AN ECONOMIC APPRAISAL OF CONSERVATION AND DEVELOPMENT AREA AUTHORITY PROJECTS IN SASKATCHEWAN

Technical Report

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&

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Report prepared for

SASKATCHEWAN WATER CORPORATION
&
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DEPARTMENT OF AGRICULTURAL ECONOMICS
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TECHNICAL REPORT

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EXECUTIVE SUMMARY

Over the past 50 years, 90 individual Conservation and Development Area Authorities (CDAA) have been created under the Conservation and Development Act of Saskatchewan of 1949 and subsequent amendments. These CDAAs have been active in establishing several hundreds of conservation and development projects across Saskatchewan utilizing various rural water control assistance programs administered originally by the Saskatchewan Department of Agriculture, but in recent years by SaskWater. The Saskatchewan Conservation and Development Association (SCDA) is an umbrella group of the individual Conservation and Development Area Authorities.

The projects were needed to alleviate flooding and drainage problems associated with excess water on agricultural lands. In addition, some projects were designed to advance soil and water conservation, back-flood irrigation and to stabilize levels of existing lakes through locally sponsored and co-ordinated programs. Assistance provided under the programs facilitated design, implementation and management of projects to control surface water flow within defined CDAA project areas.

Evaluation of the efficacy and effectiveness of public expenditure programs is necessary, from time-to-time, in order to ensure open and public accountability regarding achievements and impacts of expenditures as envisaged under the authorizing legislation. From a program management perspective, it is equally important to determine where changes, if any, are needed to improve the administration of programs in the future. In line with the foregoing principles, the main objective of this study is to complete an economic evaluation of a sample of projects undertaken under the Conservation and Development Act of Saskatchewan.

The scope of the investigation encompassed the following key activities:

- completion of a review of a sample of CDAA projects using information available from area authorities and the SaskWater;
- conduct of an economic efficiency analysis (benefit-cost analysis) and an economic impact analysis (input-output analysis) of the selected projects on a case study basis;
- identification in qualitative terms, and where possible in quantitative terms the social and environmental impacts of the projects on the region and society; and,
- design of appropriate criteria, based on results of the analysis, for selection of future projects.

In essence, this study evaluated the economic efficiency and impacts of ten conservation and development projects constructed during the past 30 years in various areas of Saskatchewan. All of the projects studied received planning, technical and financial assistance from the provincial

government to facilitate project construction and implementation.

The projects were selected for case study analysis based on data submitted by conservation and development area authorities in a voluntary survey undertaken during the initial stage of this study. All of the projects have been operating and providing benefits to area farmers and residents for at least 15 years and in several cases as long as 30 years. The rationale for selecting projects with a lengthy period of operating experience was to provide sources of data on the flows over a period years of actual costs and benefits. Historic data was then projected into the future for the life of the project and converted to constant year 2000 dollars to provide consistency among projects for analytical and comparison purposes.

The sample chosen for detailed analysis does not constitute a representative sample of the several hundreds of conservation and development projects existing in Saskatchewan. Nevertheless, the projects examined in this study are illustrative of the characteristics, costs and benefits associated with the array of projects in the province. The projects in the sample are geographically dispersed across the province, approximately in proportion to the distribution of conservation and development projects in the various areas of the province. An example of this feature, is the similar concentration of projects in the northeast and east central regions of Saskatchewan both in the sample and in the population of conservation and development projects.

The sample of projects examined are also illustrative of the main types of conservation and development projects existing in the province. For example, there are projects that are classified as single purpose drainage and flood control projects; some combine drainage and flood control features with a non-agricultural flood damage reduction features; others include back-flood irrigation features; and, one other project provides a lake stabilization feature combined with waterfowl and wildlife habitat enhancement features. There are no true multi-purpose projects in the sample but, when the projects are taken together, they illustrate most of the features that would exist in a multi-purpose project.

A spread-sheet based analytical model was developed as part of this study for the purpose of analyzing the economic efficiency and impacts of the projects. The model incorporates accepted conventional methodology for conducting benefit-cost analysis to measure project efficiency and input-output analysis for measuring direct and indirect economic impacts. Project data collected from the survey of area authorities underwent a process of clarification and refinement through follow-up telephone interviews with representatives of area authorities and SaskWater. Data for each project were subjected to analysis utilizing the model and results compiled.

The analysis conducted in this study is called *ex poste* analysis because it looks backward into time (and projects into the future) and examines the results of projects after they have been completed and in operation for many years. It examines whether results and impacts are consistent with typical expectations of efficiency and impact for such projects. The analysis provides answers to questions about whether the projects were worthwhile from the perspective of private beneficiaries as well as public beneficiaries, or society in general.

Several conclusions are reached on the basis of the analysis conducted in this study. The conclusions relate to the validity of the concept of conducting *ex poste* economic analysis; to the approach utilized and complexities of collecting reliable project data; to the methodologies employed in the economic analysis; to the model developed for conducting the analysis; and, to results of the analysis for individual projects and in aggregate.

The principle conclusions of this study are as follows:

1. The concept of conducting *ex poste* economic analysis of conservation and development project efficiency and impacts proved to be useful approach in this study but was limited in scope and reliability by data availability.

2. Use of a written survey with follow-up telephone contact was a satisfactory method for collecting the type of data needed the study. The major limitation of the survey was the low response rate due mainly to area authorities having to rely heavily on memory of members for the requested data.

3. The projects selected for detailed study do not comprise a representative sample of all conservation and development projects in Saskatchewan but they do constitute a set of case studies that effectively reflect project type and geographic distribution. The projects illustrate common project characteristics and key concepts and principles related to benefits and costs.

4. Combining project data provided by area authorities (e.g., project costs, investment time periods, etc.) with other data from secondary sources (e.g., crop yields, prices, etc.), while not perfect in terms of data quality, was an effective means of maximizing the usefulness of the analytical tools employed and of providing results for illustrative purposes.

5. The use of a spread-sheet based analytical model, incorporating the economic principles of benefit-cost analysis and input-output analysis was an excellent method for analyzing the efficiency and impacts of the projects. The methodology of meta analysis was a practical and valid way of aggregating the results of individual project analysis.

6. Methodologies developed, refined and applied in this study have potential to be used in the future for planning and analytical studies on the efficiency and impacts of single and multi-purpose projects within the context of comprehensive watershed management. Decision criteria for project acceptance would consist of the key project performance and impact indicators utilized in this study.

7. Analytical results indicate that the projects studied, based on actual historic performance, have been relatively efficient in terms of utilization of private and public

investment funds. Rates of return have been competitive with or better than other investment alternatives.

- Based on the projects analyzed in this study, economic criteria suggest that these projects have been a good investment. All projects created additional wealth in the local area, primarily for the producers. On average, a project has added (or would add over its productive life) almost $1.2 million. Average benefit-cost ration for these projects is around 2.5, and the internal rate of return, on average, is 17%. These criteria suggest that for these projects, a decision to proceed with them was a good one. This remark should be interpreted carefully, since ecosystem benefits (or costs) have not been accounted for in this study.

- Investment in these projects also brings forth major gains in income to the producers and other members of the society. On average, the projects studied contributed 10.74 times the money invested in these projects over their entire productive life.

8. Some projects presented better results than others with major differences associated with the type of project (i.e., multi-purpose projects tended to yield higher results) and the magnitude of benefitting land relative to cost (i.e., lower investment cost per acre yield higher results). Based on results obtained in this study, some of the projects with lower rates of return likely would not have been constructed or would have been designed differently.

9. Private benefits exceeded private and public costs in this study. Thus, the projects examined in this study qualify on the basis of economic efficiency criteria. They also make significant contribution to the local regional economy though economic impacts. However, most of the benefits accrued to private parties. In addition, there were several potential dis-benefits that were identified by the Area Authorities. These unfortunately could not be measured due to insufficient data (e.g., loss of waterfowl and wildlife habitat, etc.). It they could be effectively measured, social costs may challenge total benefits for certain projects.

10. Historically the projects studied have had significant direct and indirect employment and economic impacts on the local and provincial economies. These impacts will continue into the future stemming from incremental economic activity (e.g., agricultural production, investment, project operation and maintenance, etc.) generated by the projects.

Most of the projects did not indicate generation of benefits to third-parties, commonly called public goods. In fact, in these projects all benefits were captured by the private land holders or other institutions in the local (project) region.

Successful completion of this study required development of unique data collection techniques. It also required integrated use of primary and secondary data and creation of an innovative spread-sheet based model for conducting analysis consistent with application of sound economic principles. Based on experience gained in this study, several recommendations are provided to facilitate conduct of future similar studies with respect to conservation and development activities within the context of future watershed management activities.

The recommendations arising from this study and the principle reasons for each are summarized as follows:

1. Administrators of future conservation and development projects should include a systematic data collection component to ensure that key indicators on project performance and impact can be reliably measured at various stages during the life of a project.

   Availability of reliable data on project construction and operating costs as well as on bio-physical, economic and environment changes associated with the projects proved to be a major challenge in conducting this study. Data on construction activities and capital costs were difficult to access. Data on environmental impacts did not exist because environment impact assessments generally were not required when most of the projects were built. Data on project operation and maintenance activities and costs were not readily available for most projects. Secondary sources were utilized for farming practices, crops, rotations, yields for areas in which the projects are located.

2. A systematic database should be established and maintained within a one Saskatchewan government agency, in cooperation with the Saskatchewan Conservation and Development Association, to retain data collected on critical performance measurement indicators selected for future conservation and development projects.

   Because of a dearth of pertinent data, a survey instrument was developed for this project to collect data required to conduct the study. Although not many area authorities participated in the survey for various reasons, the information and data provided by those who did participate was invaluable to completion of the study.

   In summary, reliable data for conducting the economic analysis undertaken in this study could not be obtained from original sources because of the historic nature of the data and the type of paper-based data filing system utilized in the past. No original economic feasibility study was found for any of the projects studied.

3. The survey instrument developed in this study could be used at any time to update data records and support economic impact evaluation of existing conservation and development projects.

This study included design of a comprehensive survey instrument to collect pertinent data on the different classes of conservation and development projects in existence. The survey consists of questions on base line information such as the rationale for the project, and data on capital and operating costs. It also contains questions in different parts of the survey related to benefits and impacts arising from single or multi-purpose projects. A completed survey supplemented with follow-up telephone contact to clarify some responses, provides a good profile of the characteristics of a particular conservation and development project. The survey form can have ongoing usefulness beyond the scope of this study. The form can be completed by area authorities at any time and by comparing data with other projects analyzed in this study can be potentially quite a useful tool in supporting on-going project management activities.

4. The analytical model developed in this study could be readily adapted to facilitate future comprehensive watershed planning and management initiatives and to support multi-purpose project feasibility and impact analysis.

The methodology employed in this study included development of an analytical model, or tool, for conducting economic efficiency and impact analysis. The model utilizes a series of linked spread sheets for inputting and processing data, and presenting results. While the model must be adjusted to accommodate the unique features of each project, the principle steps involved in the calculations are the same for every project.

Thus, the model can be adapted to conduct analysis of projects with many different types of agricultural and non-agricultural features and can be utilized for project planning purposes, including sensitivity analysis of alternative assumptions and project design features.. In this capacity, the model could be especially useful for facilitating future studies of multi-purpose projects within the context of watershed planning activities.

5. The Saskatchewan Conservation and Development Association and SaskWater should consider alternatives for communicating and sharing with others information developed in this study about the benefits and impacts of conservation and development projects.

This results of this study indicate that conservation and development projects examined have had positive impacts on local farming operations in terms of reduced flooding and improved cropping. This information arising from this study could be of interest to local farmers and rural municipalities and could be useful to newspapers and others in preparing articles on success stories in rural Saskatchewan. The information could also facilitate informed, positive discussions in the future among various interest groups on water resource management issues and design of future multi-use projects within the context of comprehensive watershed planning and management.

The historic value and benefits, based on the results of this study, of conservation and development projects to the agricultural sector could be shared with others in working towards optimal management and utilization of scarce provincial water resources.

6. Although this study is based on a small sample, it does point out to some important guidelines for future selection of water control projects in Saskatchewan. These include:

- Projects should be subjected to an *ex ante* appraisal. Such an appraisal should encompass economic, social and environmental impacts of the project. To the extent possible, both economic efficiency and impacts related criteria should be included. Economic efficiency measures must also include non-economic impacts of the project.

- Water control projects that provide benefits (or at the same time do not destroy environmental services in the region) beyond the farm gates should be given a higher priority. This purpose would be best served through development of multi-purpose projects, which produce a range of private and public goods.

- Project capital and operating costs for water control projects should be shared commensurate with the ratio of public and private benefits generated by the project. If a project does not generate any direct public goods, it should not qualify for support by the public sector.

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G.G.P.
S.N.K.

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PART A

OVERVIEW REPORT

1.0 INTRODUCTION

1.1 Background

This section provides background information concerning the evolution of Conservation and Development Area Authorities (CDAA) in Saskatchewan. These authorities were created under the Conservation and Development Act of Saskatchewan 1949. Over the last 50 years, they have undertaken various types of rural water control assistance projects. Dominant type of projects undertaken by the CDAAs are those that are needed to alleviate flooding and drainage problems associated with agricultural lands. Other types of projects undertaken by them involved advancing soil and water conservation, and stabilization of water levels in existing lakes.

The Saskatchewan Conservation and Development Association (SCDA) is an umbrella group of 90 individual CDAAs. The location of the CDAAs are shown on a map of Saskatchewan in Figure 1.1. Most of the CDAAs in the province are located in the eastern part of the province, particularly in the northeast and southeast part, where problems associated with flooding are frequent and need for drainage exists. CDAAs vary in size from commanding only a few hundred acres to over 100,000 acres. In total, various CDAAs have been responsible for the operation of over 3,000 kilometers of drainage ditches. The area assessed for benefits from such projects is in the neighborhood of 4.3 million acres – some 9.2% of the area under crops and summerfallow in the province.[1]

Over the past 50 years, the CDAAs have been active in developing four types of projects:

1. Drainage and flood control projects
2. Drainage and irrigation projects
3. Lake level stabilization projects, and
4. Multi-purpose projects.

These projects have been undertaken through public assistance provided by the Government of Saskatchewan through Saskatchewan Water Corporation (called Sask Water hereinafter), and previously though Saskatchewan Department of Agriculture. Such assistance provided under the programs facilitated design, implementation and management of projects to control surface water flow within defined CDAA project areas.

1.2 Need for the Study

Public funds have many competing uses, and thus decisions must be made according to the objectives of the decision makers. Public investment is rationalized on several grounds, although existence of externalities and production of public goods are two most commonly cited motives for such actions.

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[1] Based on 1996 area of 35.6 million acres under crops and 10.95 million acres under summerfallow. Data obtained from Statistics Canada (1997).

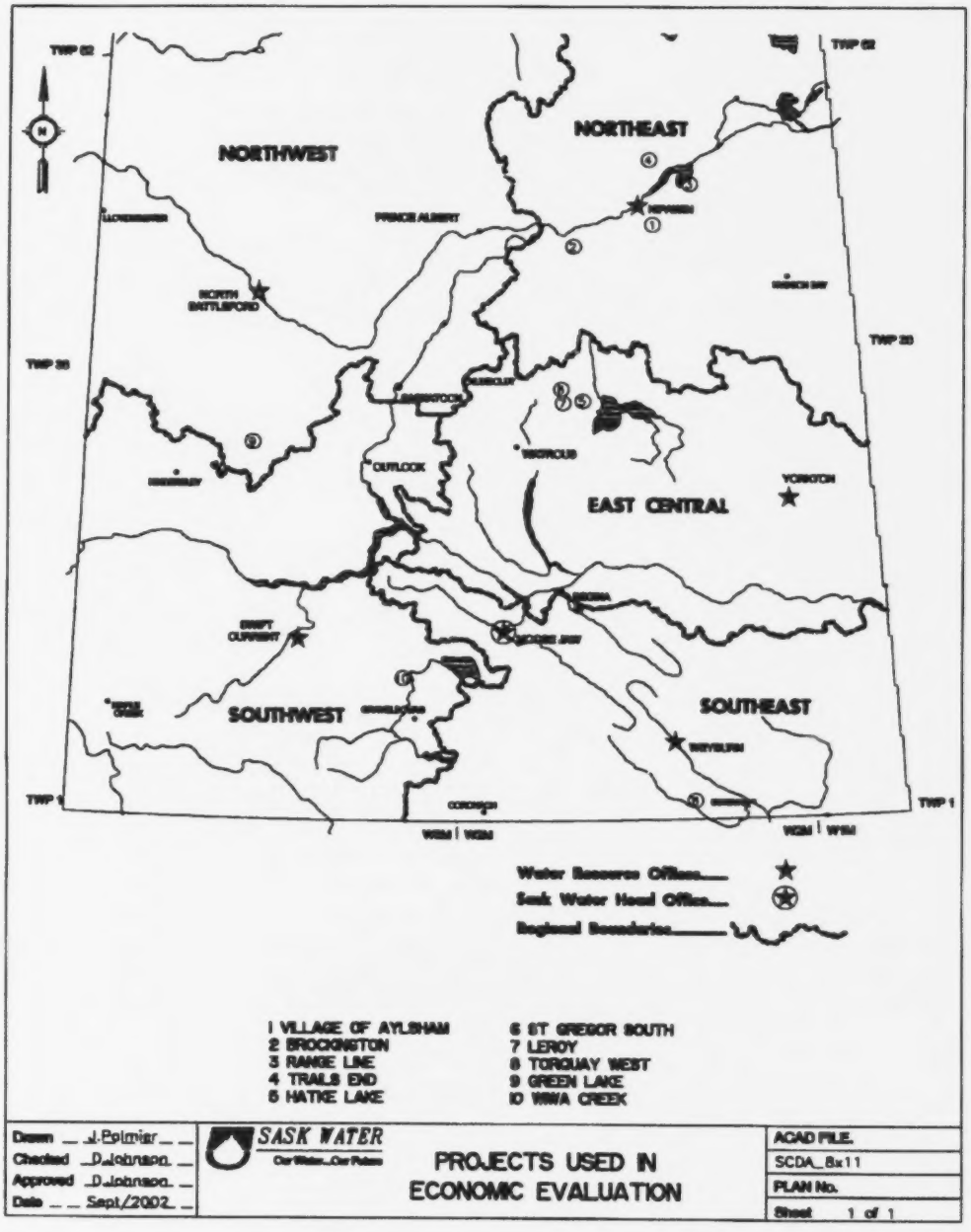

Figure 1.1: Map Showing Saskatchewan Conservation and Development Area Authority Projects

Externalities occur when undertaking of a project by the private investors leads to creation of benefits accruing to other members of the society. When economically desirable activity cannot take place through the actions of the private market place, the government must intervene and provide incentives to private entrepreneurs to correct this market failure. Public assistance, in this sense, is expected to improve welfare of the society at large. Perhaps this is the rationale behind the public assistance provided to the CDAA projects in Saskatchewan.

Under a situation of unlimited public funds, the question of whether the funds are being used properly or not is seldom raised. However, such a situation rarely exists. Over time demand for such funds increases, thereby raising the question whether existing uses of the funds are meeting the objectives of the decision makers. In addition, evaluation of the efficacy of a public expenditure program is necessary, from time-to-time, in order to ensure open and public accountability regarding achievements and impacts of expenditures as envisaged under the authorizing legislation.

The questions that need to be answered in the context of the CDAA projects include:

1. Who benefits from the CDAA projects?
2. Are the projects economically desirable – do they lead to maximization of flow of income over time?
3. What type of projects are relatively more desirable on economic grounds?
4. Do these projects create economic externalities (third party spill-over effects) in the province?, and,
5. Are there significant negative externalities created by these projects?

Answers to these questions are needed both by the public at large as well as by the program managers. Since various CDAA activities affect and impact the economic functions of the provincial economy, an economic evaluation would assist in identifying ways of improving the socio-economic returns from future investments made under the Act. From a program management perspective, it is equally important to determine where changes, if any, are needed to improve the administration of the program in the future. The evaluation also includes an examination of the process, including criteria, used for assessing and selecting projects eligible for financial and technical assistance.

In line with the foregoing principle, this study was designed to conduct an economic evaluation of a sample of Saskatchewan CDAA projects.

1.3 Objective and Scope of Study

The main objective of this study is to undertake an economic evaluation of selected CDAA projects undertaken under the Conservation and Development Act of Saskatchewan. The major emphasis in the evaluation is on the economic impacts of the projects on the regions in which they are situated, and on their overall contribution to the economic welfare of the province.

The scope of the investigation encompasses the following key activities:

- Completing a review of a sample of CDAA projects using information available from local C&D Area Authorities and the Sask Water.
- Conducting an economic efficiency analysis (benefit-cost analysis) to determine the economic desirability of the investment in these projects;
- Conduct an economic impact analysis (input-output analysis) of the selected projects to determine market-based economic externalities in the province;
- Identification in qualitative terms, and where possible in quantitative terms, the social and environmental impacts of the projects on the region and society; and,
- Design of appropriate criteria, based on results of the analysis, for selection of future projects.

1.4 Organization of the Report

This report is divided into two parts: Part A - Overview Report; and, Part B - Saskatchewan Conservation and Development Project Case Studies.

Part A contains Chapters 1 to 6. Chapter 2 outlines the methodology employed in conducting the study while Chapters 3 and 4 provide an overview of conceptual and empirical methodology of the study. Summary of the results and comparison of selected projects are described in Chapter 5. This latter chapter also discusses the implications of the study results for formulation of future project selection criteria. Chapter 6 outlines the key conclusions and recommendations arising from the study.

Part B, Chapters 7 to 16 contain the assumptions, analysis and results of analysis for each of the ten project case studies examined during the study.

2.0 OVERVIEW OF STUDY METHODOLOGY

This chapter outlines the overall methodology employed for the study. Various phases of activities related to this analysis are described here. This is followed by a description of the type of analysis that was undertaken for each of the projects and for all projects as a group.

2.1 Evaluation Study Administration

The project was guided by a Project Steering Committee (PST), consisting of representatives of the Saskatchewan Water Corporation and the Board of Directors of the Saskatchewan Conservation and Development Association. The evaluation study team met with the PST on four occasions to review the sampling frame, to review proposed survey instruments, report on progress of the study and to discuss how best to address issues related to sample selection and data collection.

The team conducted a familiarization session on the survey instrument with SCDA delegates during the March 2001 SCDA annual meeting. The team also made presentations on preliminary study findings to delegates at the SCDA annual in March 2001 and March 2002.

2.2 Overview of Methodology

The study methodology was divided into three interrelated phases of activities. These were: Phase 1 – Program documentation; Phase 2 – Detailed case studies, and Phase 3 – Meta-analysis of selected projects. An overview of the various activities in each of these phases is shown in Figure 2.2. Each of these phases are discussed further.

2.2.1 Phase One: Program Documentation

The first phase involved a review of files, documentation of the program, and selection of criteria for selecting a sample of projects for case studies. The review of the files and information contained therein was conducted for selected files at headquarters and regional offices of the Saskatchewan Water Corporation. During the later part of this Phase, a methodology was developed for selecting a sample of projects for further study. Details of this methodology are discussed in Section 2.3.

2.2.2 Phase Two: Detailed Case Studies

Conceptually, this phase of the methodology involved assessment of three major components for the selected projects; namely, validation, verification, and valuation.

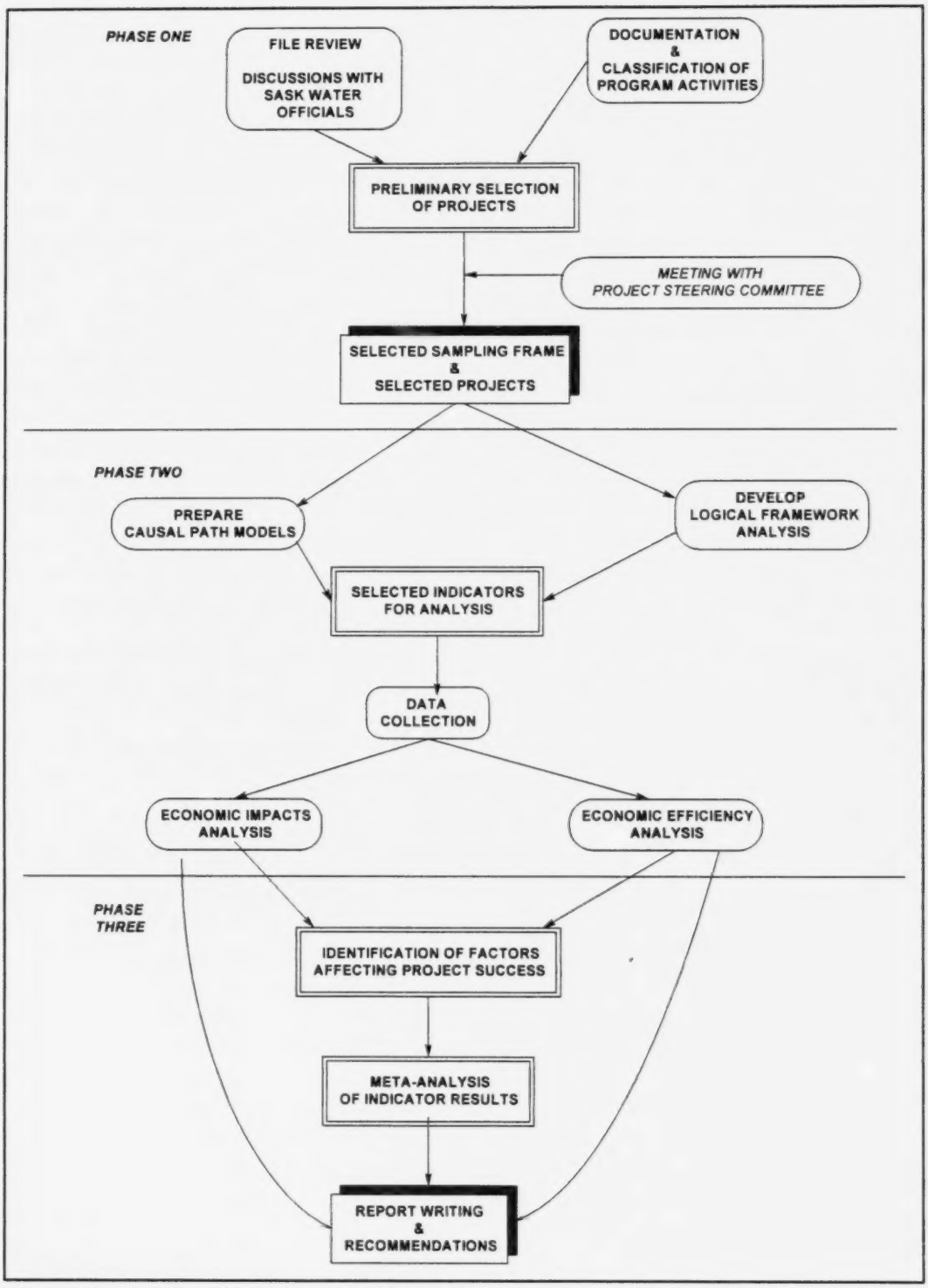

Figure 2.1: Overview of Study Methodology

- **Validation** involved the development of "causal path models" – diagrammatic representation of the anticipated impacts of the project(s) and development of a "logical framework approach." Alternative project models were reviewed in light of the overall mandate of the program under the Act, and the logical connection between actions and results expected.

- **Verification** provided the conceptual view of the appropriateness of the projects. Development of indicators for measurement project success of failure was done using information collected during the Validation sub-phase. Wherever possible, data were collected from various affected parties. Both intended and unintended effects of each of the project activities were included in the development of indicators and collection of supporting evidence.

- **Valuation** consisted of evaluating the level of selected indicators using information collected during the Verification sub-phase. Such valuation can be quantitative as well as qualitative. Three types of evaluations were included: (1) economic efficiency (net addition to the provincial economic welfare; (2) economic impacts assessment; and (3) intangible impacts assessment, including unintended impacts of the projects. Details on these tools are provided in Sections 2.3 to 2.6.

2.2.3 Phase Three: Meta-analysis

Meta-analysis integrated the outcome of individual project analysis to form a judgement regarding the overall performance of projects undertaken. The use of this approach was intended to identify and value any synergistic effects of the projects, when viewed together (as against individually). More details are provided in Section 2.6.

2.3 Economic Efficiency Analysis

A project is deemed to be economically efficient (and therefore desirable) if it contributes to the economic welfare of the society. This economic desirability is assessed in terms of benefits to the members of the society of concern and the cost of the resources engaged in the production of goods and services from the selected project. If the cost of the resources are less than the benefits, the project becomes economically desirable. The tool commonly used for the assessment of economic efficiency of a project is benefit-cost analysis. The emphasis in this methodology is on the gain in economic welfare to the society as a whole[2].

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[2] The scope of the society of relevance is decided by the accounting stance of the decision maker. For example, if the project was to be funded solely by the SCDA, only those benefits and costs borne by the SCDA members would be relevant. If the Province of Saskatchewan contributes a portion of the fund, all members of the provincial economy become relevant for the analysis.

The methodology of benefit-cost analysis has now become fairly standard. Estimation of the benefits proceeds using the concepts of consumer and producer surplus, whereas the estimation of costs is based on the opportunity cost of the resources required for the project.

Economic efficiency is measured through a number of indicators. Among these benefit-cost ratio, net present value, and the internal rate of return are most commonly used. If the funds have been used in the creation of projects that are economically efficient, one could conclude that there has been a sound use of public and private funds in the development of a particular project.

2.4 Economic Impact Assessment

Individual citizens, businesses, community, and commercial organizations, as well as various levels of the government agencies, have long been interested in the nature and magnitude of local economic changes that result from a variety of public and private sector initiatives. When new economic activities take place, a number of economic consequences occur in the region as well as in the regions beyond. These consequences could be economic in nature, and, as well, may have social or environmental connotations. The former is a subject for the economic impact assessment of a project.

Impacts of a project are created through the existence of economic linkages among various businesses. Money received by one firm is spent on procuring its input requirements or paid to various factors of production. These lead to more economic activities in the region and are called secondary impacts. Estimation of total impacts (direct and secondary impacts) is the major focus of economic impact assessments. These economic impacts are typically estimated using an input-output model. In this study, the model used was for that for the Province of Saskatchewan with agricultural production and type of farm disaggregated, enabling a more accurate analysis of economic impacts on a provincial basis.

The input-output model of Saskatchewan was updated to the 1994 level of technology and economic structure. The source of the model and data for disaggregation purposes was obtained from the Input-Output Division of Statistics Canada.

Multipliers derived from the updated input-output model were used to measure changes in the economy. Indicators used in this study measure changes in economic output, income, gross domestic product and employment derived from investment and operation of the project, as well as from the agricultural and non-agricultural economic benefits arising from the project.

2.5 Social and Environmental Impacts

Some of the consequences of economic development projects are non-economic in nature. In fact, all economic development programs produce some positive and some negative impacts on the society and on the environment. Since such changes do contribute to the welfare of the society, their inclusion in the final appraisal of the project is important. Having said that, it should be noted that

evaluation of social and environmental impacts of the conservation and development projects was not a part of the terms of reference for the present study. Nevertheless, these impacts were identified, wherever possible, during the project survey. These data were useful primarily for identifying qualitative implications, rather than quantitative impacts. This is an area that requires further study in the future.

2.6 Meta-Analysis

Meta modeling is a statistical method to abstract away from unneeded detail for regional analysis by approximating the outcomes of a complex process model through statistically validated parameteric forms. It uses the results of benefits-cost analysis and economic impact assessments to identify project characteristics that lead to attainment of the desired project objective. Use of meta modeling is very common in industrial simulation and agroecosystem models. Typically this type of analysis requires a large sample[3].

In this study, meta-analysis (using meta modeling) was undertaken using results of the economic analyses. These results were used in conjunction with individual project characteristics to seek underlying patterns. The narrow scope of the project sample ultimately utilized, may limit the reliability of the results of the meta-analysis. However, it provides an indication of the direction and magnitude of the overall, cumulative impacts of conservation and development projects constructed during the past fifty years.

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[3] Although it is difficult to place a numerical value on a small sample size, in statistics a sample of 30 or less is defined to have small sample properties.

3.0 EMPIRICAL METHODOLOGY

Empirical methodology for the study involved development of conceptual impacts of a Conservation and Development Area Authority (CDAA) project using a causal path model and the Logical Framework Analysis. This assisted in the identification of indicators that could be significant for decision making regarding such projects. Empirical methodology involved selection of the study sample. Data collection and other aspects of the empirical methodology were selected next. These details are provided in this chapter.

3.1 Conceptual Impact Analysis using a Causal Path Model

A causal path model presents the interrelationship among various activities and their impacts over a period of time. The overarching consideration is the objective of the project that needs to be attained. Various activities are listed and the output that emerges from such activities is analyzed in terms of likely impact on the constituents of the objective function.

A causal path model for a flood control and drainage projects is shown in Figure 3.1. A typical objective of such a project will be to improve the economic development of the regions (farm and non-farm) that is subject to frequent severe flooding. The means for achieving this would involve: (1) Planning of a project; (2) Designing of such a project; (3) Construction of an appropriate structure; and (4) Operations of a project. Once a project has been in operation for some time, periodic monitoring and evaluation is also an activity that would ensure attainment of the stated objective.

The resulting output will be a fully operational flood control structure that would lead to positive and negative impacts on the region. The changes may occur over a period of time. In Figure 3.1, all three types of changes are identified – Short run (such as increased land base); Medium run (Changes in agricultural land use and productivity); and Long run (Improved financial position of farmers and other members of the regional society).

3.2 Logical Framework Analysis of a CDAA project

The Logical Framework Analysis (also named as the LogFrame) is a tool for the preparation, monitoring and evaluation of a project. It is also useful for analyzing the components of a project and the logical linkages between means and ends. A LogFrame model is a 4-by-4 matrix. The rows correspond to project activities and three levels of objectives – direct project outputs, the broader purposes of the project, and the ultimate goal. The columns are used to describe the purposes, activities, inputs and outputs of the projects; to define indicators for measuring them and means of verification; and to specify the main assumptions on which the project design is based. A presentation of a flood control and drainage project is shown in Table 3.1.

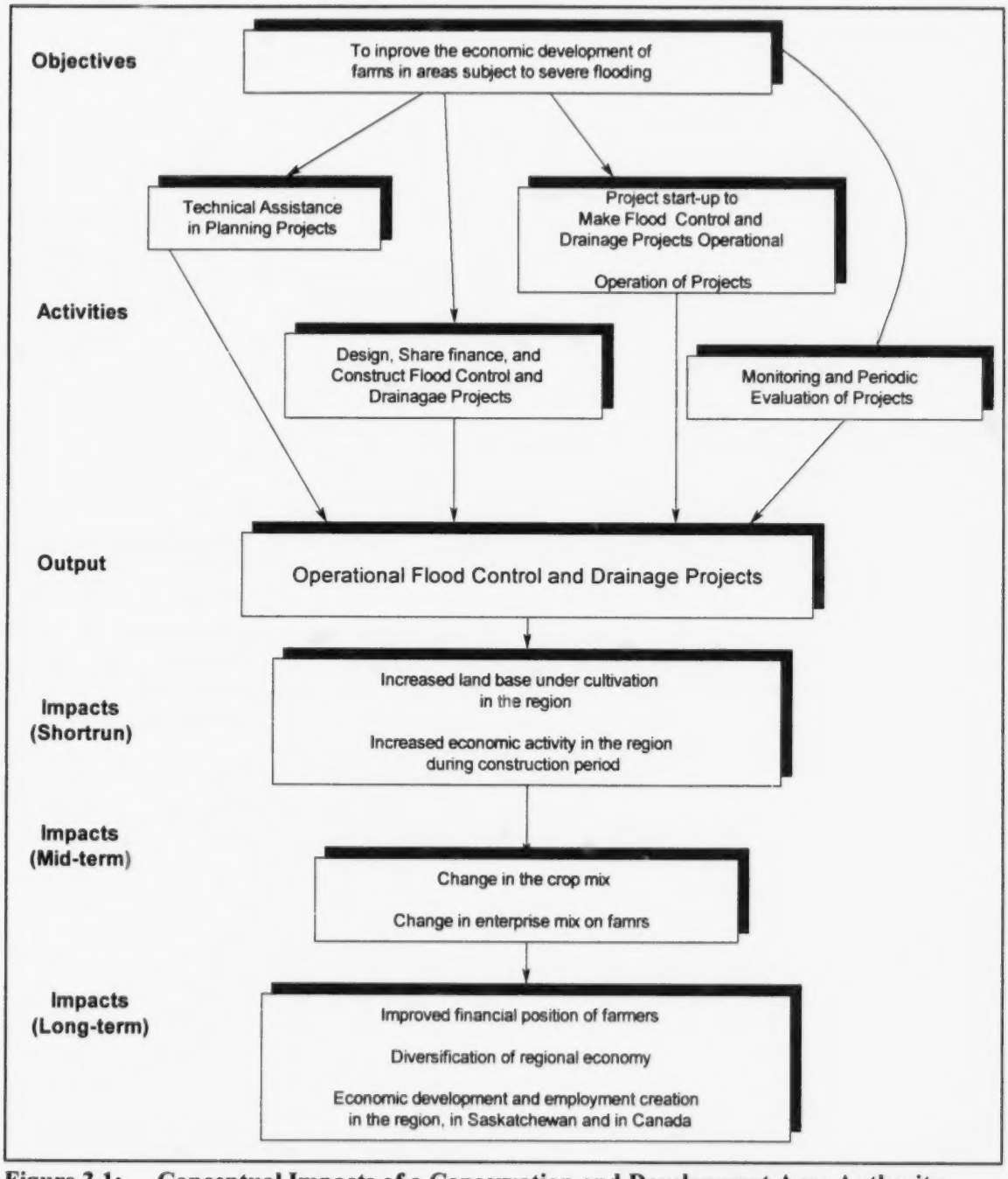
Objectives
To inprove the economic development of farms in areas subject to severe flooding
Technical Assistance in Planning Projects
Project start-up to Make Flood Control and Drainage Projects Operational
Operation of Projects
Activities
Design, Share finance, and Construct Flood Control and Drainagae Projects
Monitoring and Periodic Evaluation of Projects
Output
Operational Flood Control and Drainage Projects
Impacts (Shortrun)
Increased land base under cultivation in the region
Increased economic activity in the region during construction period
Impacts (Mid-term)
Change in the crop mix
Change in enterprise mix on farms
Impacts (Long-term)
Improved financial position of farmers
Diversification of regional economy
Economic development and employment creation in the region, in Saskatchewan and in Canada

Figure 3.1: Conceptual Impacts of a Conservation and Development Area Authority Project for Flood Control and Drainage

Table 3.1: Logical Framework Matrix for the Flood Control and Drainage Projects

Particulars	Narrative Summary	Measurable Indicators	Means of Verification	Assumptions / Uncontrollable Factors
Goals	To improve economic welfare of farm people in areas subject to periodic flooding	Improvement in economic welfare of farm people	People's change in the economic status People's willingness to pay for the service	Past evidence is a good reflection of the future of the project over its lifetime. Assumes that diversification at the farm level would bring growth and stability
Purpose	To alleviate flooding and drainage problems associated with agricultural lands	Magnitude of reduction in flooded areas under different flood regimes Increase in drained area previously uncultivable	Discussions with Project manager(s) Sask Water records of flooding magnitude before and after the project Focus group meetings of project participants	Farmers participation is based on economic motive Past weather patterns are a good indicators of future weather variability Long term change in climate patterns would not affect the economics or viability of the project

Particulars	Narrative Summary	Measurable Indicators	Means of Verification	Assumptions / Uncontrollable Factors
Output	Development of the infrastructure for the project Expansion of Cultivated area Increased income of farmers	Development cost for the infrastructure Operations and Maintenance Cost for the infrastructure Number of farmers served Change in area under crops and forages Change in the yield or productivity Savings in costs to farmers with the project Change in the producer surplus	Sask Water records Interview of Project Manager Conservation and Development Area Authority (CDAA) records Focus group meeting of farmers (beneficiaries) Interview of CDAA Association personnel	Project development used the most cost-effective technology Operations and maintenance of the project is cost effective Farmers preference for risks remains unchanged over the remaining life of the project Policies of the federal, provincial and local governments remains unchanged in the future

Particulars	Narrative Summary	Measurable Indicators	Means of Verification	Assumptions / Uncontrollable Factors
Activities	Feasibility analysis for the proposed project	Existence of feasibility analysis and revision in proposed project	Sask Water files	Land quality and topography
	Construction of the project	Cost of the project	Sask Water Files CDAA files	Future technology of production same as in the past
	Associated improvements in infrastructure by other agencies	Increased Costs to other agencies	CDAA files / interviews Interviews of RM authorities	Future crop and livestock prices
	Operations of the project by the CDDA	Operations costs of the project	CDAA files / interviews	
	On-farm Decisions	Change in area under cultivation Change in the crop and enterprise mix Change in the yield Change in the net farm income	Focus group of farmers or farm interviews Interview of CDAA authorities	
	Actions of Other members of the regional society	Effect on the economic status of other members of the society and agencies in the project region	CDAA authorities	

The goals for the flood control and drainage project is the same as noted in the causal path model – to improve the economic welfare of farm people in areas subject to severe and / or frequent flooding. Measurement of this is done using indicators showing change in economic welfare of farm people through either change in their economic status or their willingness to pay for the services provided by the project. Major assumption in the achievement of this goal is that the past is a good reflection of the future, and that the project would complete its productive life.

Major output of the project is identified in the third row, along with indicators for measurement and verification. Various sources of data are identified here along with assumptions that need to be made for the analysis of the project.

3.3 Indicators for Measurement

Based on the results of the causal path model and the LogFrame model, a number of indicators (key data points) became apparent. These subsequently became the subject of data collection process, to be described later on in Section 3.6. In Table 3.2, a list of such indicators (data points) is shown for a flood control and drainage project.

Table 3.2: Selected Indicators for a Flood Control and Drainage Project

Indicators on Project Activities	Indicators for Project Output
Project Cost – Construction	Farm Level Physical Changes resulting from the project
Project Cost – Maintenance and Operations	Farm Level Net Returns
Other Capital Investment (Other Agencies)	Impact on Non-Farm Sector in the Region
Farm Level Investment	Other Non-Farm Level Effects
Farm Level Operations	

3.4 Design of Project Sampling Frame

The initial goal of this study was to obtain a representative sample of conservation and development projects that broadly reflected the composition and characteristics of projects across the province. The project sampling frame was designed following a review of files and was based principally on the following guidelines:

1. Projects should be clustered by focus of their activities into four main types of projects:

   (i) Flood Control and Drainage;
   (ii) Back-flood Irrigation;
   (iii) Multi-purpose projects; and,
   (iv) Lake Level Stabilization.

2. Projects within a focus category should be further stratified by geographic region based either on Saskatchewan Water Corporation administrative regions or eco-

system regions based on soil types, land use and general landscape characteristics.

3. Within each focus category in a region, projects should be classified according to their size (e.g., measured by the total amount of public and private expenditures, benefitting land area, etc.) and date of project initiation.

Notwithstanding other factors, the general approach for selection of sample project was to emphasize larger projects and projects that have had reached some maturity (in terms of achieving impacts). To meet the latter criteria, it was decided to select only those projects that have been completed and operating for at least fifteen years[4].

The initial target was to select a cross-section of 18 projects using a combination of above guiding principles. Details are shown in Table 3.3.

Table 3.3: Selected Characteristics of Projects Under Targeted Sample Frame

Project Characteristics	Proposed Scope
Focus -- Flood and Drainage	One project per region, large in size, and completed for 15 years or more. Sub-total : 5 projects
Back-flood Irrigation	One project per region, large in size, and completed for 15 years or more. Sub-total : 5 projects
Lake Stabilization	3 Projects in total Selected in consultation with the Project Steering Committee
Multi-purpose projects	One per region
Total Number of Projects Targeted as Case Studies	18

For the purpose of the sampling frame, 4 focus categories, and 5 regions were assumed which could theoretically lead to 20 different project types. However, based on file review and discussions with the project steering committee, it was assumed that at least 10 such groups would not likely have a project suitable for case study analysis.

The regions of the province targeted for purposes of case study selection included the north-east,

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[4] The latter preference for project type relates both to greater probability of obtaining more reliable data and more meaningful measures of project benefits and impacts.

east-central, south-east, south-west and west-central regions. These regions represent the areas of greatest activity in construction and operation of conservation and development projects over the under the legislation over the past 50 years.

In the final analysis, only ten projects could be included. Reasons for this smaller sample size are described in the next section.

3.5 Data Collection Process

Information used for conducting the analysis in this study was collected through a combination of the approaches, involving literature review, file review, survey, interviews:

3.5.1 Literature Review

A search of relevant literature was conducted related to the latest methodologies for measuring benefits derived from the types of single and multi-purpose projects under investigation in this study. The search revealed that there is a paucity of current information and analysis related to the types of conservation and development projects constructed in Saskatchewan or in neighboring provinces. Relevant documents and secondary data sources identified during the literature review are cited in the References section of this report, and a comparison of study results with those of the previous studies in Chapter 14.

3.5.2 File Review

The file review involved a search of relevant files in headquarters and regional offices of the Saskatchewan Water Corporation with respect to the availability and suitability of historical data for analytical purposes. Many of the conservation and development projects potentially suitable for analysis were originally constructed under programs administered by the Conservation and Development Branch of the Saskatchewan Department of Agriculture, prior to formation of the Saskatchewan Water Corporation.

While original files now reside in regional offices of the Saskatchewan Water Corporation, it was determined upon investigation of the files, and in consultation with Saskatchewan Corporation officials, that a considerable human resource effort would be required to identify and manually extract relevant data and information from the files for purposes of analysis. Resulting discussions with the PSC, lead to a decision to conduct a survey of the CDAAs for purposes of collecting project specific data.

3.5.3 Survey of Area Authorities

A survey guide was developed for purposes of conducting a survey of CDAAs. The guide was designed to collect historical data from files, as well as from past and current members of the CDAAs related to particular projects. Primary data to be collected included project construction and operating costs, as well as data on agricultural and non-agricultural benefits associated with the project. Each CDAA Board was asked to select one or more projects which they felt had been operating a sufficient length of time to generate measurable benefits and for which they were reasonably confident of the validity of the data.

The survey draft survey guide was reviewed with the PSC and an information session on the survey guide was held for delegates attending the March 2001 Annual Meeting of the SCDA. The guide was modified to incorporate suggested changes from these meetings. The survey guide used for surveying area authorities is reproduced in Appendix A. With the assistance of the SCDA, surveys were mailed to all CDAA in Saskatchewan during May 2001. The CDAAs worked on completing the surveys during the fall and winter of 2001-2002. After several follow-up contacts by the SCDA with the CDAAs, a total of 18 surveys were returned prior to the March 2002 Annual Meeting of the SCDA.

3.5.4 Interviews with Area Authorities

A pilot study of the Brockington project was conducted to test draft survey questions, and to determine the type and availability of data needed to conduct the analysis. The pilot study included a focus group meeting with members of the local CDAA Board. Subsequent surveys received were followed up with telephone interviews of the identified contact person.

The purpose of these follow-up interviews was to obtain additional, often more detailed, data on agricultural and land use practices under both 'without' and 'with' project conditions. In some instances, clarification of cost data as well as data on non-agricultural benefits was also sought from the contact persons. In other cases, the CDAA requested that project construction cost data be obtained from the Saskatchewan Water Corporation files as they considered their local files to be incomplete or unavailable.

As of May 1, 2002, sufficiently reliable data had been compiled for 10 projects. A list of these projects is shown in Table 3.4. Selected projects were located in five of the six regions of the Province – Northeast, East Central, Southeast, Southwest, and West Central. With respect to the type of project, no projects were selected for the lake level stabilization, although the Hatke Lake project has some similar characteristics. However, since much of the non-agricultural (wildlife and recreational) aspects were excluded from the analysis, it is treated as a flood control project. Only one project has a backflood irrigation components along with drainage. Of the remaining nine projects, five of them were agricultural drainage projects (simply referred to as drainage projects) with a significant flood control, while the remaining four were primarily drainage projects.

Table 3.4: Projects Included for Analysis

Project Name	Region	Type of Project			
		Agric. Drainage	Flood Control	Backflood Irrigation	Lake Level Stabilization
Aylsham Village	Northeast		X		
Brockington		X			
Trails End		X			
Ranch Creek		X			
Hatke Lake	East Central		X		X*
Leroy West			X		
St. Gregor South			X		
Torquay West	Southeast	X			
Wiwa Creek	Southwest			X	
Green Lake	West Central			X**	

* Although the project has some lake level stabilization aspects, these could not be evaluated in this study. Thus this project is almost like a typical agricultural drainage project.

** This project has a limited benefits from water availability from the drainage lake, although the project is essentially similar to a backflood project.

3.5.5 Interviews with Officials

During the course of the investigation, interviews were conducted with several Saskatchewan Water Corporation officials as well as members of the SCDA and officials of other organizations potentially impacted by conservation and development projects. These included informal discussions with several Ducks Unlimited officials on methodology for economic valuation of potential habitat changes.

3.6 Study Assumptions

Study assumptions related to discount rates, crop prices and crop production technology changes are discussed in the following sections.

3.6.1 Discount Rates

The use of a discount rate accounts for the time value of money. Capital investments in the various conservation and development projects assessed in this study occur over a period of years. Likewise, benefits generated by the projects are realized over a number of years following completion of project construction. A discount rate allows calculation of the present value of the flows of project costs and benefits over time on a consistent and comparable basis. At the same time, present value estimates vary with the magnitude of the discount rate utilized.

Discount rates are normally set at values that represent the real rate of return on an investment over time after allowing for the effects of price inflation. The real rate of return is essentially the current interest cost of borrowing funds to finance a project minus the current inflation rate. For example, with a current cost of borrowing of 6.5% and inflation of 1.5%, the real rate of return would be 5%.

A risk premium can be added to the real rate of return to reflect the risk of not realizing the expected return if projected conditions are not realized. A risk premium for conservation and development projects could be an additional 5%. Thus, a real rate of return of 10% or higher would be consistent with expected returns on alternative uses of investment funds for new business development initiatives.

To assess the sensitivity of discount rates, 5% and 10% discount rates are used in this study. Inflation is accommodated in this study through the use of price indexes to convert current dollar expenditures (past capital expenditures, and past and future operating and maintenance expenditures) on project costs to constant year 2000 dollars.

3.6.2 Crop Price Assumptions

For the analysis of agricultural benefits, two sets of crop price assumptions were used in this study. The first assumption reflects current base year 2002 prices and the second assumption reflects normal or 10-year average prices (1991-92 to 2000-2001).

There is no advantage in using indexes to convert crop prices during the project period to constant year 2000 dollars because of the cyclical nature of crop prices. The use of the two alternative assumptions tests the sensitivity of project returns to reasonable variations in crop prices. Crop price assumptions used in this study are shown in Table 3.5. As indicated in the table, current crop prices are both higher and lower than the 10-year average prices, reflecting the varying nature of crop production and prices and the crop mix assumed for each project.. The source of price data is Saskatchewan Agriculture and Food (2001).

3.6.3 Crop Production Technology Assumption

All crops included in the study for various projects were assumed to be grown using the technology of the time. Two types of technologies are noteworthy: Conventional Tillage and Conservation Tillage. Both of these technologies were used in the proportion they have been adopted in the project area. Unfortunately no project region specific data were available. As a proxy, it was assumed that the producers on the project would have adopted these technologies at the same level as done by the producers in the regions (Rural Municipality).

Table 3.5: Crop Price Assumptions

Crop	Base Year Price, 2002	10-Year Average Price, 1991-92 to 2000 -2001	Units
	- current dollars -		
Wheat	4.70	4.01	bu
Barley	2.31	2.42	bu
Canary Seed	0.11	0.13	lb
Peas	3.35	4.30	bu
Flax	5.08	6.62	bu
Lentils	323.00	348.60	tonne
Canola	7.31	7.03	bu

The missing information was the adoption path for this technology. Using Statistics Canada (1996) data, it was assumed that by the year 2000, farmers have adopted these technologies at the level reported for 1996. It was further assumed that the adoption process was linear and from the inception of the project.

Crop production costs were based on the normalized cost of production data obtained from Saskatchewan Agriculture and Food Web Site (see Saskatchewan Agriculture and Food, 2002). During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations. To incorporate these changes, CDAA project administrators were asked to identify the typical crop mix before and after the project.

4.0 SALIENT FEATURES OF SAMPLE PROJECTS

The ten selected projects were analyzed using the methodology described in Chapters 2 and 3. Results for individual projects are each presented under an individual chapter in PART B of this report. In this Chapter, a summary of project characteristics are presented. These are based on the survey of CDAAs where these projects are located. Salient features of these projects are summarized in Table 4.1 for the projects located in the Northeast region of Sask Water, whereas those in the East Central region in Table 4.2. Projects in the other three regions (Southeast, Southwest, and West Central regions) are shown in Table 4.3. Information contained in these tables is self-explanatory, and therefore, these would not be described in all details. Some key features of these projects are described in the following two sections of this chapter.

4.1 Summary of Pre-Project Characteristics

Before the construction of the drainage channels and associated structures, damages to crops was a common occurrence. This is exhibited by the fact that in 6 out of 10 project areas, crop losses occurred in 8 out of 10 years. In the other four project areas, although total crop loss was limited to at most 25% of the time, other type of crop damage existed. This included reduced yields of crops either through delayed seeding of the crops, or through weed and other infestation.

Various projects varied in size – area benefitted from the construction of the project. One can measure the benefitting area in two ways: (1) Very severe crop damage area, as indicated by the area subject to flooding; and (2) Total area benefitting from the project. Table 4.4 shows the distribution of the sample project by each of these criteria. As shown there, for half the projects, the directly flooded area tended to be smaller (less than 1,000 acres). However, when one examines the distribution based on the total affected area half the projects contained over 5,000 acres of cropland.

In terms of the age of the projects, the oldest project in operation commenced benefits in 1977 (for 25 years by the year 2002) and the youngest one in 1993 (nine years of benefits). There were only two relatively younger projects; rest of the projects started operation in the late seventies to early eighties. In five of the ten projects included in this study, flood benefits extended to non-farm structures. These included damages to houses, railroads, and roads

4.2 Post-Project Changes

Construction of the projects brought about a number of economic improvements. For the most part, these included improvement in crop yields, and development of new crop area. Yield improvements on the reclaimed area were close to the area average. This amounted to having no crops in some years to average crop production.

Table 4.1: Summary of Project Characteristics, Northeast Region, Saskatchewan

Category	Aylsham Village	Brockington	Trails End	Ranch Creek
Rural municipality	457	459	488	369/399
Area of province	Northeast	Northeast	Northeast	Northeast
Soil zone	Black	Black	Black/Grey	Black
Construction:				
- construction time-path	1986-89	1982-89	1980-81	1987-93
- type of construction	Bridge/Structures	Ditch/Structures	Ditch/Culverts	Ditch/Structures
- > 75 % earthwork		yes		yes
- 50 to 75 % earthwork			yes	
- < 50 % earthwork	yes			
Agriculture Benefits without project:				
- 100% crop loss frequency	0 out of 10 years	8 out of 10 years	9 out of 10 years	8 out of 10 years
- crop rotation		100% barley	100% fallow	100% barley
- area directly flooded	0	2197	732 acres	1,094 acres
- yields when not 100% loss		10% < average	0	10% < average
- crop rotation		barley	P/W/C/W	barley
- severely delayed seeding/salinity	0	733	800 acres	2,560 acres
- yields under severe conditions		0	30% < average	15% < average
- fertilizer cost reduction			50% < average	33% < average
- crop rotation	P/W/C/W	W/C/B/P	P/W/C/W	
- moderately delayed seeding	47,166 acres	4,394 acres	3,028 acres	0
- yields under moderate conditions	5% < average	10% < average	10% < average	
- fertilizer cost reduction	10% < average	0	25% < average	
Agriculture Benefits with project:				
- cropping frequency	100%	100%	100%	95%
- spring back-flood	0	0	0	0
- crop rotation	P/W/C/W	W/C/B/P	P/W/C/W	P/W/C/W-B
- area directly reclaimed	0	2,197 acres	732 acres	1,094 acres
- yields on reclaimed area		area average	area average	area average
- other benefitting area	47,166 acres	4,393 acres	3,828 acres	2,560 acres
- yields on other benefitting area	area average	area average	area average	area average
Waterfowl/Wildlife Benefits				
- changed habitat area	no	yes	no	yes
Water Quality Impacts	no	no	no	no
Flood Damage Reduction				
- damage events without project	average 20/year	0	0	0
- damage events with project	0/year	0	0	0
- cost to repair each damage event	$3,000/house			

Table 4.2: Summary of Project Characteristics, East Central Region, Saskatchewan

Category	Hatke Lake	Leroy West	St Gregor South
Rural municipality	339	339	339/369
Area of province	East Central	East Central	East Central
Soil zone	Black	Black	Black
Construction:			
- construction time-path	1978-81	1974-82	1981-87
- type of construction	Ditch/Structures	Ditch/Structures	Ditch/Structures
- > 75 % earthwork			
- 50 to 75 % earthwork	yes	yes	yes
- < 50 % earthwork			
Agriculture Benefits without project:			
- 100% crop loss frequency	2 out of /10 years	8 out of 10 years	2 out of 10 years
- crop rotation	P/W/C/W	P/W/C/W	P/W/C/W
- area directly flooded	830 acres	2,800 acres	7,064 acres
- yields when not 100% loss	10% < average	10% < average	10% < average
- fertilizer cost reduction	25% < average	25% < average	25% < average
- crop rotation			
- severely delayed seeding/salinity	0	0	0
- yields under severe conditions			
- crop rotation	P/W/C/W	P/W/C/W	P/W/C/W
- moderately delayed seeding	6,523 acres	8,400 acres	49,452 acres
- yields under moderate conditions	10% < average	10% < average	10% < average
- fertilizer cost reduction	25%< average	25% < average	25% < average
Agriculture Benefits with project:			
- cropping frequency	100%	100%	100%
- spring back-flood	0	0	0
- crop rotation	P/W/C/W	P/W/C/W	P/W/C/W
- area directly reclaimed	830 acres	2,800 acres	7,064 acres
- yields on reclaimed area	area average	area average	area average
- other benefitting area	6,523 acres	8,400 acres	49,452 acres
- yields on other benefitting area	area average	area average	area average
Waterfowl/Wildlife Benefits			
- changed habitat area	positive	no	no
Water Quality Impacts	positive	no	no
Flood Damage Reduction			
- damage events without project	0	average 1/year	average 5/year
- damage events with project	0	0/year	0/year
- cost to repair each damage event		$6,000/railroad	$2,000/road

Table 4.3: Summary of Project Characteristics, Southeast, Southwest and West Central Regions, Saskatchewan

Category	Torquay West Southeast	Wiwa Creek Southwest	Green Lake West Central
Rural municipality	6	104/134	318
Area of province	Southeast	Southwest	West Central
Soil zone	Dark Brown	Brown	Dark Brown
Construction:			
- construction time-path	1984-85	1968-92	1969-77
- type of construction	Ditch/Culverts	Ditch/Structures	Ditch
- > 75 % earthwork	yes		yes
- 50 to 75 % earthwork		yes	
- < 50 % earthwork			
Agriculture Benefits without project:			
- 100% crop loss frequency	9 out of 10 years	1 out of 4 years	9 out of 10 years
- crop rotation	100% flax	50:50 wht-sum	100% flax
- area directly flooded	665 acres	2,652 acres	682 acres
- yields when not 100% loss	10% < average	10% < average	10% < average
- crop rotation			
- severely delayed seeding/salinity	0	0	0
- yields under severe conditions			
- crop rotation	L/W/C/F		
- moderately delayed seeding	651 acres	0	0
- yields under moderate conditions	10% < average		
- fertilizer cost reduction	0		
Agriculture Benefits with project:			
- cropping frequency	100%	100%	100%
- spring back-flood	0	2652	snow hold
- crop rotation	L/W/C/F	H/W/L/C	L/W/CS/P
- area directly reclaimed	665 acres	2,652 acres	682 acres
- yields on reclaimed area	area average	30% > average	25% > average
- other benefitting area	651 acres	0	0
- yields on other benefitting area	area average		
Waterfowl/Wildlife Benefits			
- changed habitat area	no	no	negative
Water Quality Impacts	no	no	no
Flood Damage Reduction			
- damage events without project	0	0	average 2/year
- damage events with project	0	0	0/year
- cost to repair each damage event			$2,000/road

Table 4.4: Distribution of Sample Projects by Area Affected

Directly Flooded Area (Acres)	No. of Projects	Total Affected Area (Acres)	No. of Projects
< 1000	5	< 1500	2
1000 - 2000	1	1501 - 5000	3
2001 - 3000	3	5001 - 10000	2
> 3000	1	> 10000	3
Total	10	Total	10

On the moderate damaged areas, the improvements in yield were mostly in the neighborhood of 10% of the average yield, whereas on the more severely damaged areas, crop yield improvements in some cases of up to 50% were reported. However, the median range was 25% of the area average.

Most of the non-farm damages from flooding did not occur after the construction of the project. This further induced more economic benefits to the local people.

Most project administrators did not report any negative impact on the wildlife or other natural resources. Only one of the project was reported to have a negative impact on the wildlife habitats.

5.0 SYNTHESIS OF PROJECT APPRAISAL RESULTS

Ten CDAA projects were analyzed in this study, each with their own particular characteristics, either in terms of nature of the project, or the scope of the output (benefits) created. Each of these analyses and their results were summarized in PART B, Chapters 1 to 10. The purpose of this chapter is to put all these results together and try to understand why the differences in the various economic indicators exist. These might provide the insights into characteristics that might make a project more attractive on economic grounds.

5.1 Project Characteristics

Although conceptually a number of characteristics of a project may contribute to its desirability on economic efficiency grounds and on the basis of economic impacts created by it, the following factors were hypothesized to be significant.

1. **Investment Cost of the Project**

   Since most of the economic analyses consider cost of developing a project either implicitly or explicitly, magnitude of the cost should have a negative impact on the economic efficiency, and positive impact on the economic impacts. This is because in the benefit-cost analysis, costs of the projects are treated as negative benefits. In the economic impacts analysis, the magnitude of the impacts are determined by the first time expenditures; higher these expenditures, higher are the secondary impacts.

2. **Productive Life of the Project**

   Life of the project has a positive influence on the contribution it can make towards the benefits generated (thereby adding to the economic desirability) and / or the secondary impacts emanating from the expenditures incurred in connection with various project activities.

3. **Nature and Magnitude of Farm Level Improvements**

   Since most of the CDAA projects are inspired by the farm level changes, nature and magnitude of changes at this level should have a significant impact on the results of economic analyses. The nature of the change may refer to additional area reclaimed as a result of the project, as against only improvements in the productivity of the land base under the project. Higher the area reclaimed and / or gain the productivity, more economically desirable would a project be and higher would be its economic impacts on the region. One should note that there would exist a synergistic effect if the project provides both new area as well as productivity gains.

4. **Size of the Project**

Existence of economies of size in a CDAA project would suggest that larger is the project higher would be its economic desirability, since cost per unit of benefits should decline. The major reason behind the presence of such economies would be fixed structures. If the structures have a larger capacity, the cost of construction and maintenance will be shared by a larger and larger area under the presence of economies of size. Measurement of the size of a project, however, in reality, may be complex. A simpler measure would be the area affected by the project. However, this measure would suffer from the limitation of non-comparability, since not all projects reclaim new land base for agricultural production. Furthermore, if a project generates both agricultural and non-agricultural benefits, this measure would be biased against such projects.

5. **Nature and Magnitude of Non-Agricultural Improvements**

Since some CDAA projects have alleviated damages to the non-farm sector, presence of such benefits should lead to higher economic desirability. However, economic impacts of such a project may be somewhat lower, since lower level of damages means less expenditures in correcting the problem, thereby leading to lower multiplier effect.

6. **Environmental Damage Created by the Project**

Typically society welfare function is assumed to include all commercial / monetary as well as environmental goods. Many of these environmental goods have a personal value to individuals, which can be valued. Generally speaking, if a project destroys some environmental goods that have a monetary value to the members of the society, it lead to lower economic desirability for that project.

Although a number of other factors can be identified, on account of small sample size, this list was also kept small. Furthermore, on account of the fact that this study did not undertake an assessment of environmental changes brought about by various projects, the sixth factor was not considered any further. Similarly, on account of the fact that most of the sample projects has similar project life, this was also dropped from the list of considered factors.

Four characteristics of the projects were included as criteria for examination of sample projects: These are:

1. Type of Project: All projects were divided into three types: One, flood control projects, which included both farm and non-farm-level damage alleviation; Two, drainage project, which included projects with flood damage alleviation only at the farm level; and Three, drainage and backflood irrigation project. Although

one project (Hatke Lake) has components of lake level stabilization, on account of the fact that this aspect of the project was not included in the study, it was not given a separate category.

2. Farm Level Benefits: These benefits were defined as the incremental net gain to the producers from the operation of the project. To remove the bias resulting from the different size of the project, there were expressed on a per acre basis. The size was measured as the physical area affected by the project.

3. Investment Cost: Investment costs included for this characteristic included total construction cost of the project. Thus, all maintenance and rehabilitation costs were excluded. Like the previous factor, it was expressed on a per acre basis.

4. Size of the Project: Size of the project was measured in terms of the agricultural area benefitting from the operation of the project. This area included both reclaimed area as well as that area where productivity gains were realized.

These factors were used for further examination of the ten projects reported previously in this report.

5.2 Results of Economic Efficiency Analysis

As noted earlier, economic efficiency analysis is performed to investigate the economic desirability of investment projects. Three criteria are commonly used for this evaluation:

(1) Net Present Value (NPV) of the project: The NPV of a project is the difference between the benefits generated from it and the cost, both in discounted terms. If the NPV is positive, the project is economically desirable; higher the NPV, more contributions the project makes to the economic welfare of the society.

(2) Benefit - Cost Ratio (BCR): The BCR is the ratio of discounted stream of benefits and discounted stream of costs of a project. A BCR greater than one indicates that the project is economically desirable. Higher the BCR for a project, more contributions does the project make to economic welfare of the society.

(3) Internal Rate of Return (IRR): The IRR is estimated using the stream of net benefits (benefits minus costs). It reflect the rate of interest at which discounted value of benefits equals that for the costs. Higher the IRR, more economically desirable is the project.

Results for the above three criteria for the sample projects are shown in Table 5.1. Projects are arranged by the NPV criterion, with BCA and IRR shown in the other two columns. All results are using 5% discount rate and 10-year average farm level prices.

Table 5.1: Economic Efficiency Related Criteria for Sample CDAA Projects

Project Name	NPV in Thousand $	Benefit-Cost Ratio	Internal Rate of Returns (%)
Aylsham Village	$2,933	4.39	33.08
Brockington	$701	1.58	9.81
Trails End	$395	2.17	11.11
Ranch Creek	$561	2.55	22.3
Hatke Lake	$620	2.28	13.64
Leroy West	$897	1.6	12.18
St. Gregor South	$4,808	3.72	19.7
Torquay West	$117	1.3	7.37
Wiwa Creek	$951	3.38	30.02
Green Lake	$323	2.56	15.23

Results indicate that all sample CDAA projects meet the economic efficiency criterion under the set of assumptions made for the study. All the NPVs are positive, all BCRs are greater than one, and the internal rate of return from the investment is greater than 5% – the rate of discount used. With the exception of the Brockington and the Torquay West projects, all projects even qualify as economically desirable at a discount rate of 10%.

If one ranks these projects on the basis of their value of contribution to the economic welfare of the people of the province, St. Gregor South project add the most, while Aylsham Village and Wiwa Creek projects the next largest. If one applies the IRR criterion to rank the projects, Alysham Village and Wiwa Creek projects generate a return of 30% or over. The BCR and IRR criteria do (as they should) provide similar rankings of projects.

One should be careful in interpreting these estimates. In many projects, effect on the ecosystem were noted, but not incorporated quantitatively in this analysis. Thus, the above result do not truly reflect the social welfare of the Saskatchewan society. If these environmental impacts are negative, the

results might be overestimating the social worth of these projects. However, this issue is left for future investigations.

5.3 Factors Affecting Economic Efficiency of a Project

Four characteristics of the projects were selected above for further examination of economic efficiency. This analysis is presented in this section. Readers are reminded of the smaller sample size (only 10 projects). Furthermore, since a random sampling(selection) process was not followed, representativeness of these results for the entire CDAA project group cannot be claimed. Thus, these conclusions should be attached with these projects only.

Projects were classified by the nature (type) of the projects using the three categories noted Section 5.1. As shown in Figures 5.1 and 5.2, respectively for the IRR and BCR measures of economic efficiency, backflood projects are the best group of projects. The next economically desirable projects are those with flood control, with a significant non-agricultural flood damage alleviation component associated with them. Agricultural drainage projects (those did not have any other benefits to the society, other than improving the economic position of farmers), had the lowest return on investment to the society as a whole. The benefit-cost ratio, as shown in Figure 5.2, suggested that backflood irrigation and flood control projects had almost identical economic desirability.

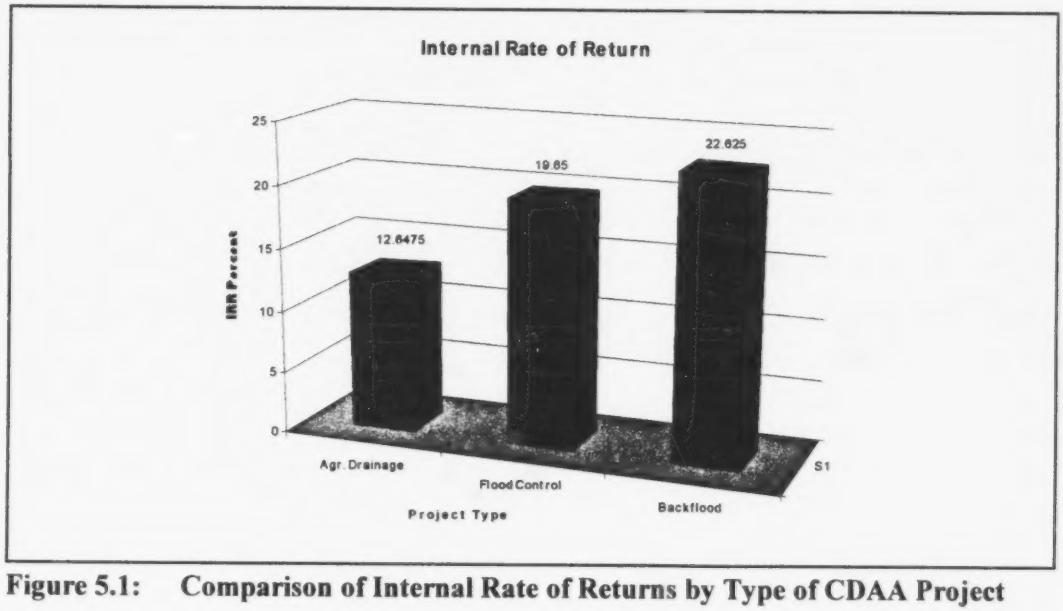


Figure 5.1: Comparison of Internal Rate of Returns by Type of CDAA Project

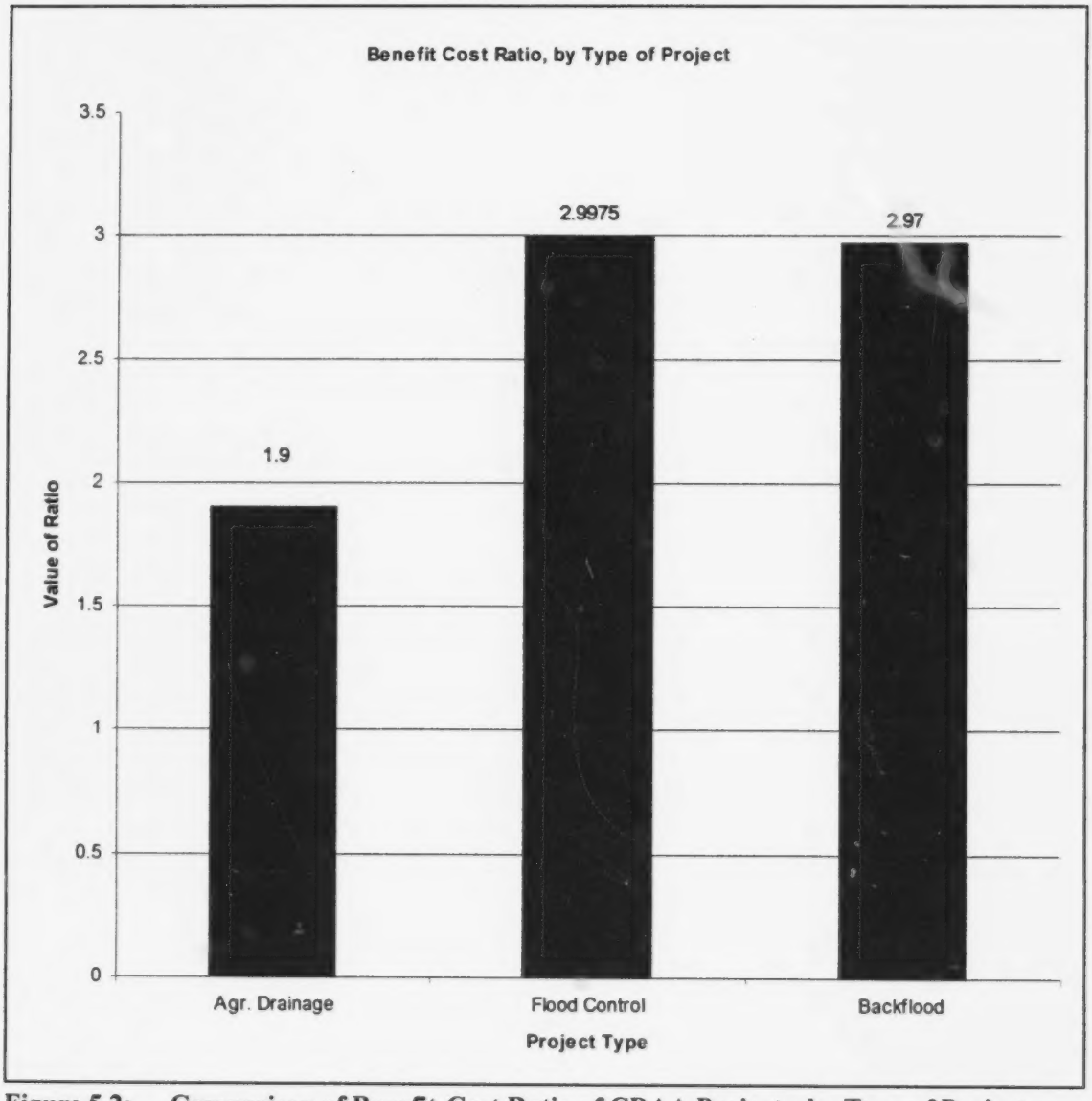


Figure 5.2: Comparison of Benefit-Cost Ratio of CDAA Projects, by Type of Project

Analysis of various projects' economic efficiency indicators was also undertaken using the other three characteristics – Level of farm level benefits per acre; Initial construction cost per acre of benefitted area, and Project size. These results are displayed in Figures 5.3 to 5.5, respectively.

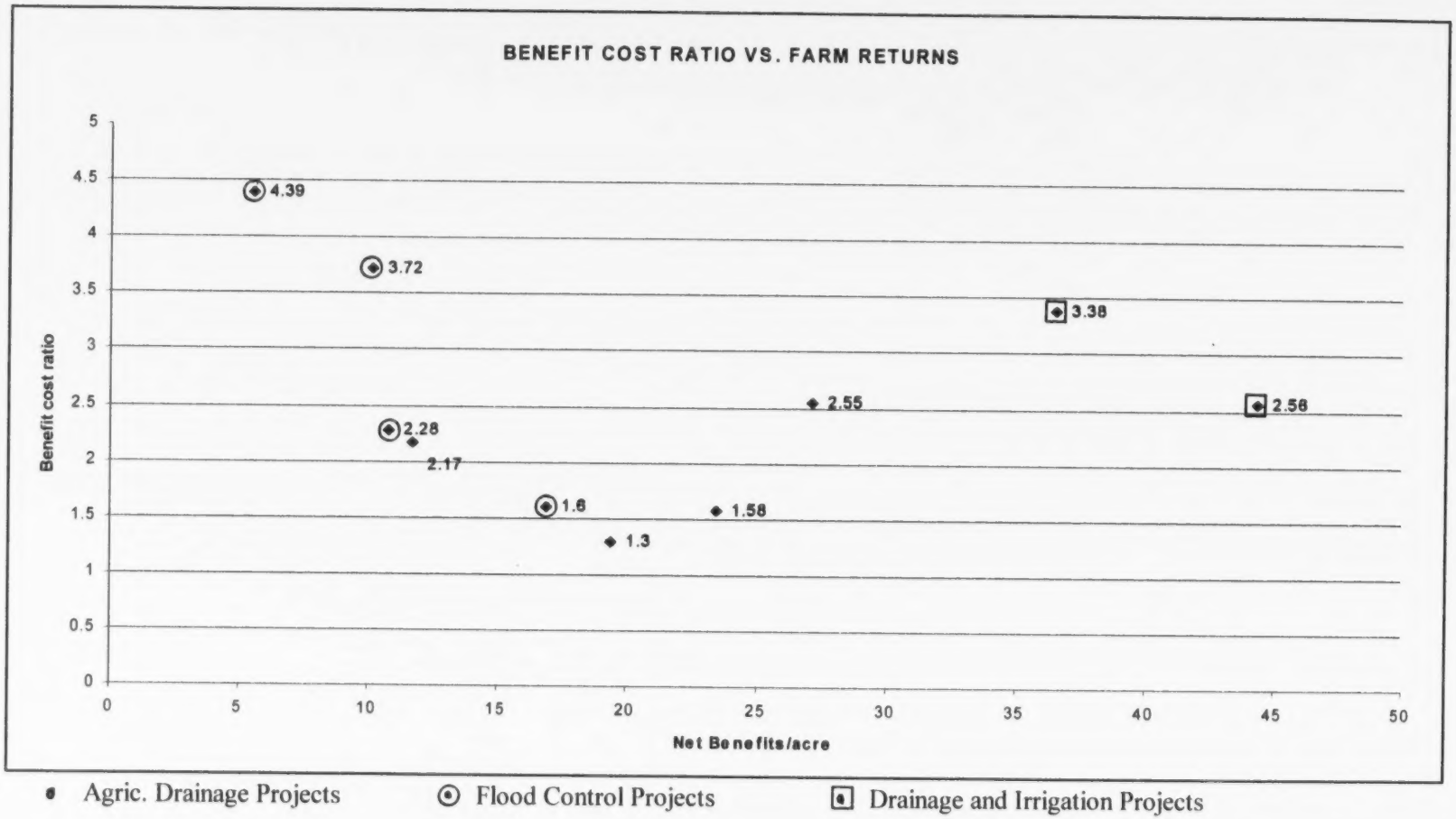


Figure 5.3: Relationship Between Benefit-Cost Ratio and Farm Level Benefits from the Project

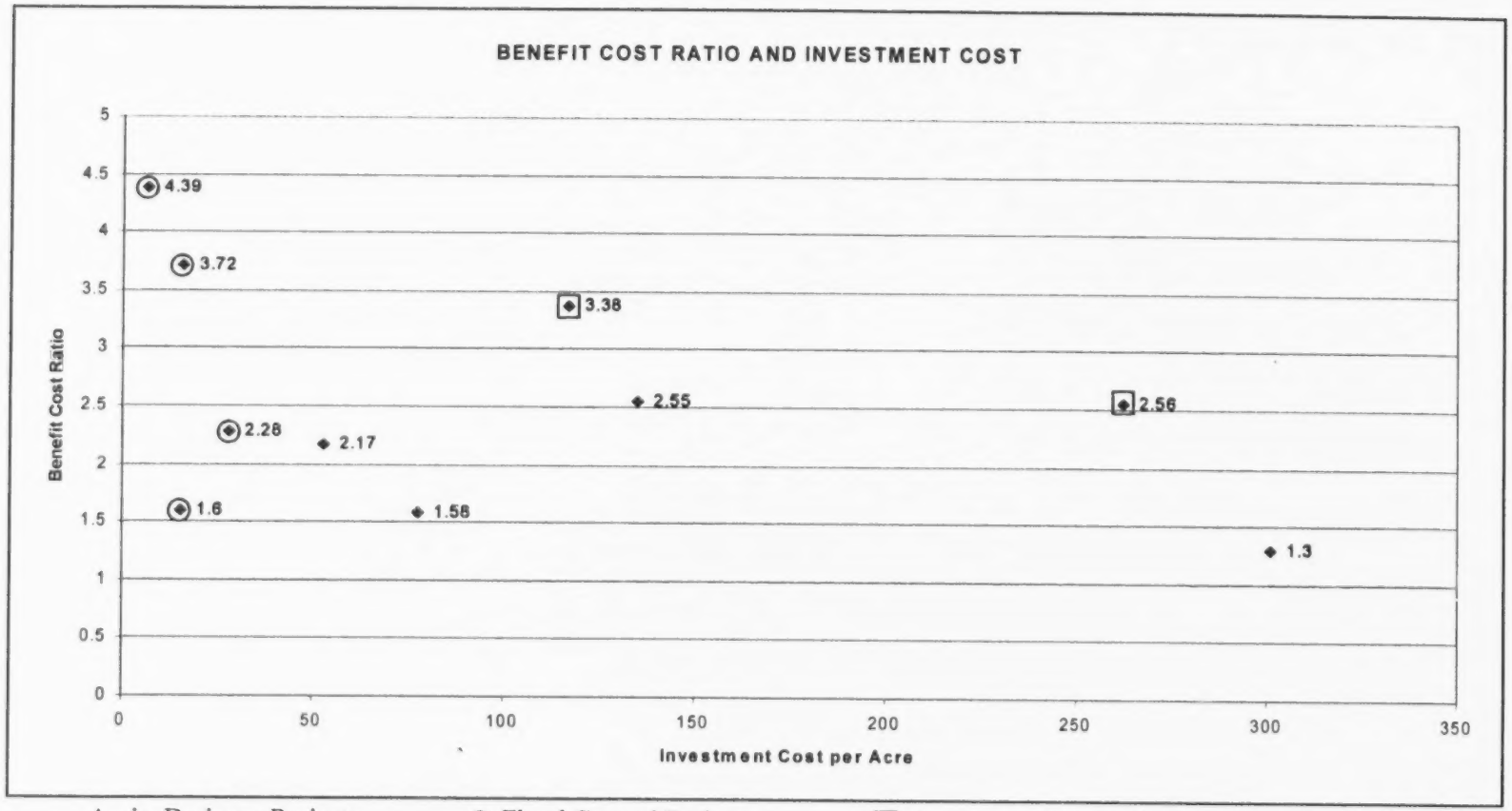


Figure 5.4: Relationship Between Benefit-Cost Ratio and Project Capital Investment

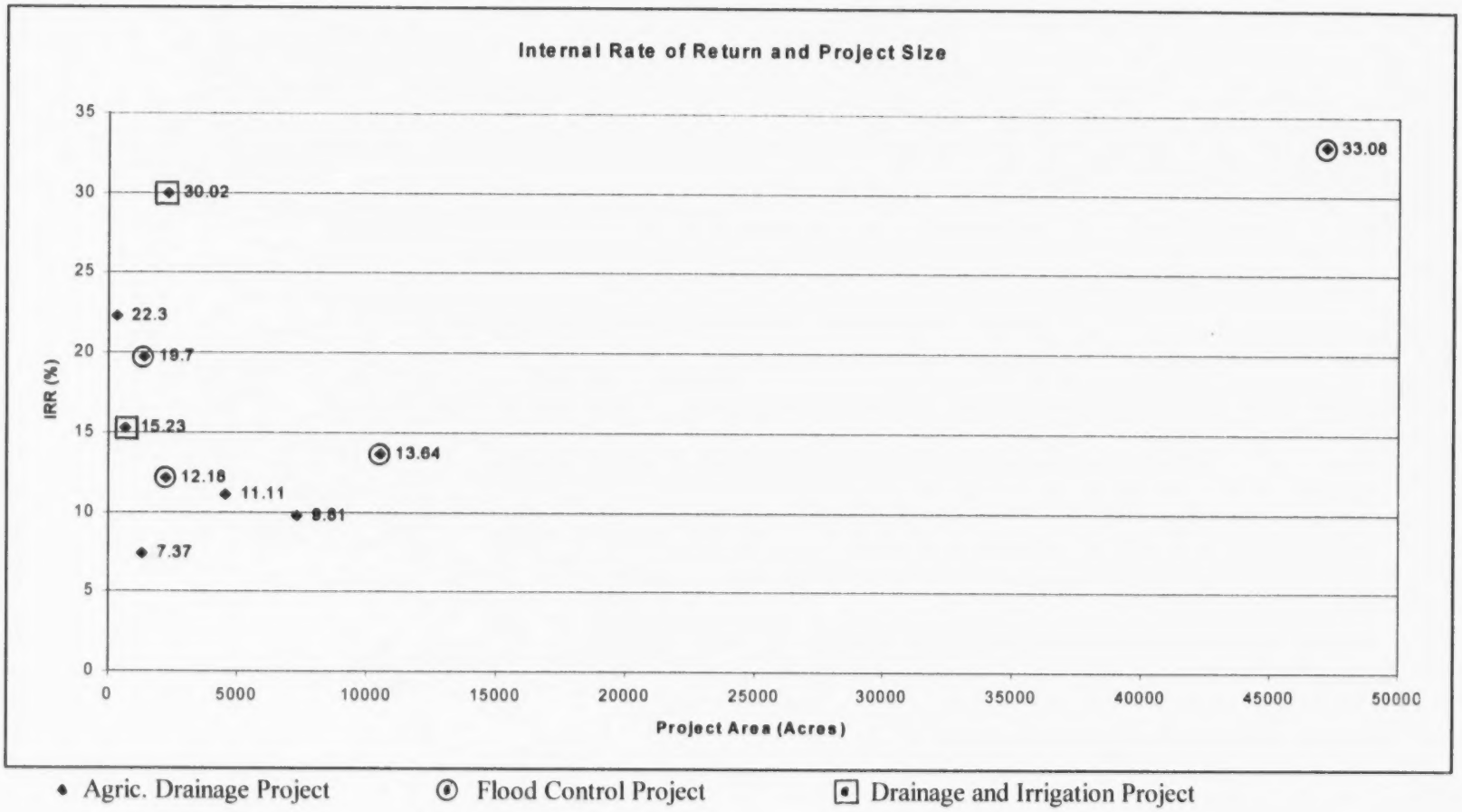


Figure 5.5: Relationship Between Internal Rate of Returns from a Project and Project Size

Relationship between economic desirability of a project and net benefits at the farm level showed mixed results by itself. Some of the projects with lower farm level returns yielded relatively higher benefit-cost ratios. A further superimposition of type of project clarified the results further. Many of the projects with relatively smaller level of farm level benefits also yielded some non-farm level benefits (making them a flood control project). Thus, if a project has a lower farm level returns, existence of flood damage alleviation benefits in the non-farm sectors help the project gain its status as being economically desirable. Irrigation projects (coupled with drainage) produce higher benefit-cost ratio relative to the level of on-farm benefits.

When the estimated benefit-cost ratios for a project were examined against the investment cost of the project, initially no clear pattern emerged. The type of project factor was superimposed. Generally speaking, projects with lower investment cost yield higher benefit-cost ratios, which is to be expected on theoretical grounds. Among the flood control projects, lower the investment costs, higher were BCRs. Among the drainage project, cost of construction was not a clear and decisive factor.

The last factor attempted to analyze the relationship between project's economic desirability criterion and project characteristics was the project size. Size was measured in terms of the agricultural area that was directly benefitted by the project. As shown in Figure 5.5, results did not show any clear and decisive pattern. With the exception of the drainage and irrigation project (Wiwa Creek), internal rate of returns were higher as project became larger. Given a certain size of the project, presence of non-farm flood control benefits tended to improve the economic desirability of the project.

To further test the effect of various project characteristics on economic desirability of the project, a regression analysis was undertaken using the Internal Rate of Return as the dependent variable. Results are shown below:

$$IRR_i = \underset{(4.88)}{10.66^*} - \underset{(9.76)}{0.007}\ BY\text{-}FC_i + \underset{(6.97)}{9.848}\ BY\text{-}IR_i + \underset{(14.39)}{4.598}\ RATIO_i + \underset{(0.00021)}{0.00036}\ SIZE_i$$

$R^2 = 0.528 \quad n = 10 \quad F = 1.39$

* Significantly different from zero at p=0.1

where, i stands for projects

IRR	Internal rate of return on a project
BY-FC	Binary variable for flood control project (takes a value 1 if a project is classified as a flood control project; 0 otherwise)
BY-IR	Binary variable for irrigation project (takes a value 1 if a project is classified as an irrigation project; 0 otherwise)
RATIO	Ratio of farm level benefits and capital cost (both on a per acre basis)
SIZE	Benefitted area of the project in acres

Although results of the regression analysis are theoretically plausible, they lacked statistical significance, in part due to the small sample size. All variables had a positive coefficient, suggesting that an increase in the project area or in the level of farm benefits relative to investment cost would

lead to higher internal rate of returns. The exception to this was the inconsistent sign for the flood control projects. A higher rate of return on the irrigation projects was also supported by the analysis. A goodness of fit of 52.8% suggested that these variable account for only a little over a half of the total variability in the sample projects' internal rate of returns.

5.4 Results of Economic Impact Assessment

Regional development benefits arise from the functioning of the economic system with various economic sector trading with each other. Thus, a change in one sectors purchases triggers a series of impacts. The end result is an economy that is now functioning at a higher level of economic output. As sales of various industries rise, so does their value added components. More workers are hired to meet the need for higher production triggered by higher demand for products resulting from the project activities. Higher employment resulting in more wages and salaries paid to workers, along with higher profits and managerial returns in various industries that are affected, lead to another round of impacts on the economy – impact through consumption expenditures of these workers and family members. Together with the industry sales, these consumption induced changes result in higher income in the hands of local residents.

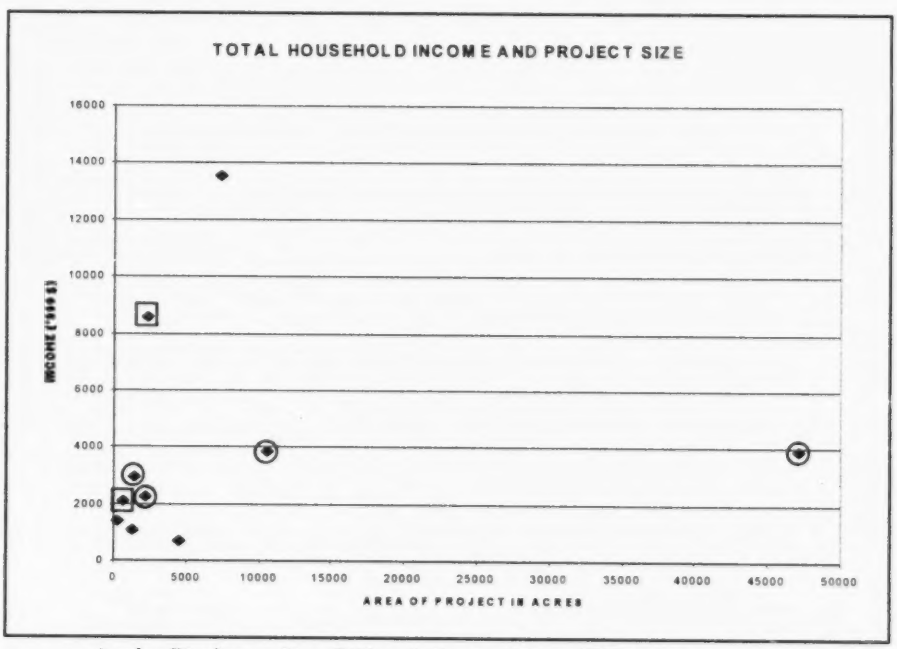
Since the Saskatchewan provincial economy does not produce all goods and services that are needed at a given point in time. Some of these are imported. When the Saskatchewan economy improves as a result of CDAA projects, a part of these impacts are also felt in the regions outside the provincial boundaries through imports into Saskatchewan. However, given the accounting stance of this study, these changes are not considered to be relevant.

Saskatchewan level impacts of CDAA projects are summarized in Table 5.2. These impacts are over the life of the project, and therefore, are determined by the productive life of the investment. To standardize such differences, these values were converted into Net Present Value form, making a comparison more appropriate.

Since the size of the project is a major determinant of regional economic development activities, larger projects should have a more positive influence on the regional incomes. However, as shown in Table 5.2 and Figure 5.6, larger projects such as the St. Gregor South, Alysham Village, Trails End, and Green Lake projects, do not necessarily display such tendencies. Thus, one could conclude that regional development impacts are more complex and are determined by other characteristics of the projects than captured by the benefitting area. All sample projects, as indicated in Table 5.2 contribute positively to the regional economy of Saskatchewan through their respective activities. Gain in the household income range from $712 thousand to over $13 million over the life of the project. Similar changes are also noted for the employment creation, with the exception of the Green Lake project. For the Green Lake project, reduction in the flood damage for non-farm sector reduced the income of the people in the region, thereby leading to lower employment.

Table 5.2: Economic Impacts Related Criteria for Sample CDAA Projects

Project Name	Net Present Value at 5% Discount Rate and 10-Year Average Prices in Thousand $			Employment in Full-Time Equivalent No. of Workers
	Sales of Industries	Gross Domestic product	Household Income	
Aylsham Village	$901	$4,256	$3,912	66
Brockington	$4,597	$3,336	$2,198	298
Trails End	$5,078	$4,887	$3,870	164
Ranch Creek	$5,530	$3,396	$2,262	53
Hatke Lake	$2,495	$3,490	$2,918	69
Leroy West	$15,303	$11,767	$8,571	482
St. Gregor South	$11,755	$16,219	$13,529	252
Torquay West	$3,739	$2,211	$1,418	40
Wiwa Creek	$2,014	$1,479	$1,072	56
Green Lake	$731	$2,283	$2,062	18



• Agric. Drainage Pro. ⊙ Flood Control Pro. ⊡ Drainage and IRR. Pro.

Figure 5.6: Relationship Between Impact on Household Incomes and Project Size

5.5 Factors Affecting Economic Impacts of a Project

Analysis of economic impacts of the CDAA projects was undertaken on lines identical to that for the economic efficiency evaluation. The variable of interest selected for this analysis was the "Investment Income Multiplier", which was measured as the ratio of total income generated using a 5% discount rate and 10-year average prices, and capital cost of the project in 2000 dollars. Results are shown in Figure 5.7 for capital cost of the project per acre, in Figure 5.8 for net farm benefits on a per acre basis, and in Figure 5.8 for the size of the project. One should note that the "income multiplier from investment" is not a conventional input-output model based multiplier, and therefore, no similarity in interpretation should be attached to this measure.

Income multiplier when plotted against the initial capital cost per acre suggests, as shown in Figure 5.7 a negative relationship. Thus, higher cost projects do not necessarily show a higher regional development benefits. When the type of project was superimposed, typically flood control projects were producing a higher multiplier than the other projects. Relationship between farm level benefits (expressed on a per acre basis) was somewhat mixed, although as shown in Figure 5.8 when type of project was superimposed, in spite of lower level of farm level benefits, the project has a higher income multiplier. Thus, it would appear that existence of flood damage alleviation on non-farm sector enhances the regional development impacts of a project. Size of the project, as shown in Figure 5.9, showed even more mixed results.

In order to identify the net effect of various variables, a regression analysis, similar to that for the internal rate of returns, was undertaken. The following results were obtained:

$$\underset{\text{MALI}}{} = \underset{(2.21)}{3.149} - \underset{(4.42)}{1.731}\ \text{BY-FC}_i - \underset{(3.16)}{1.959}\ \text{BY-IR}_i + \underset{(6.51)}{23.29^{*}}\ \text{RATIO}_i - \underset{(0.00009)}{0.00015}\ \text{SIZE}_i$$

$R^2 = 0.858 \quad n = 10 \quad F = 7.57$

* Significantly different from zero at $p = 0.05$

where, i stands for projects

MULL	Income multiplier from investment
BY-FC	Binary variable for flood control project (takes a value 1 if a project is classified as a flood control project; 0 otherwise)
BY-IR	Binary variable for irrigation project (takes a value 1 if a project is classified as an irrigation project; 0 otherwise)
RATIO	Ratio of farm level benefits and capital cost (both on a per acre basis)
SIZE	Benefitted area of the project in acres

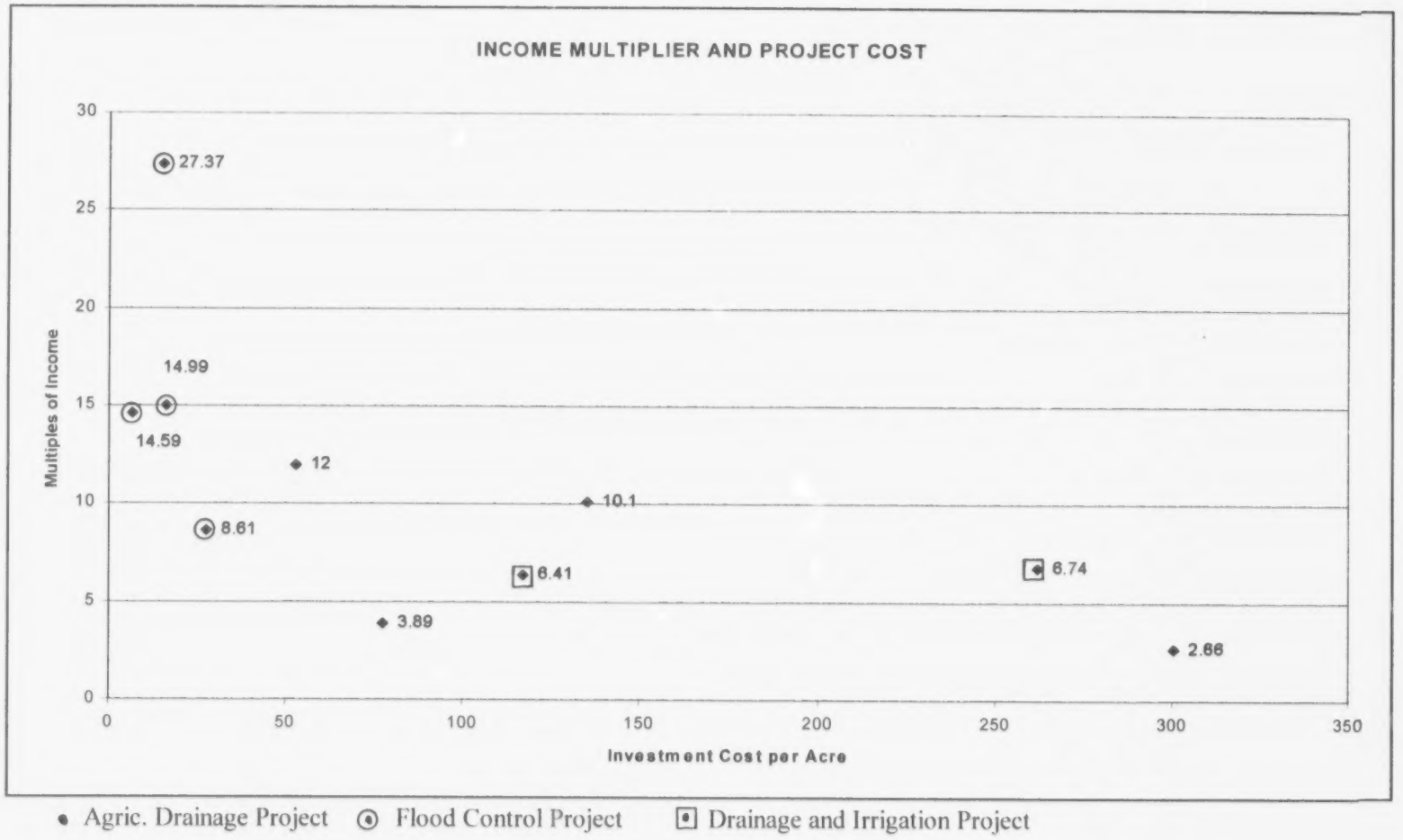


Figure 5.7: Relationship Between Investment Income Multiplier and Initial Project Cost

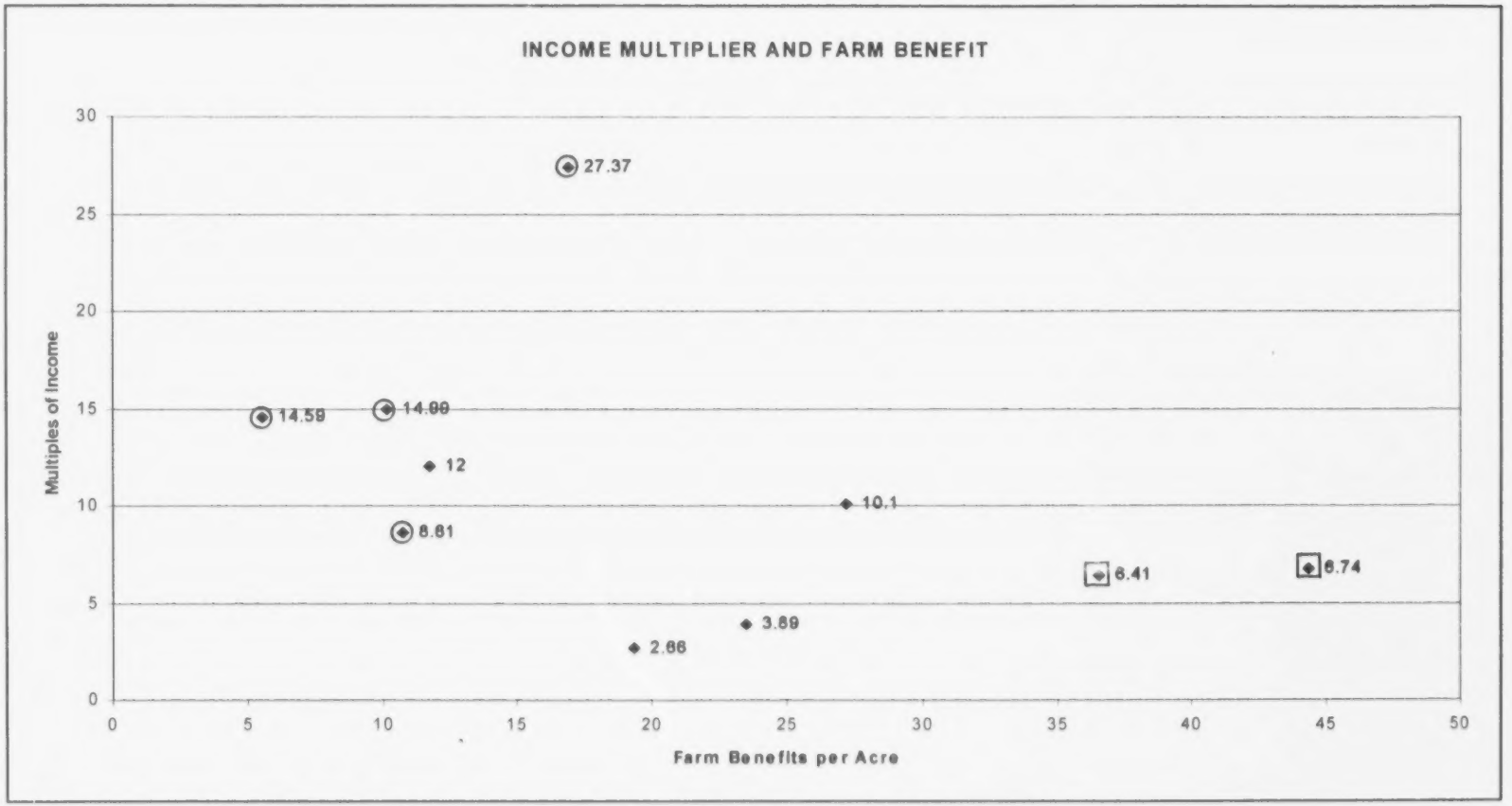


Figure 5.8: Relationship Between Investment Income Multiplier and Farm Level Benefits

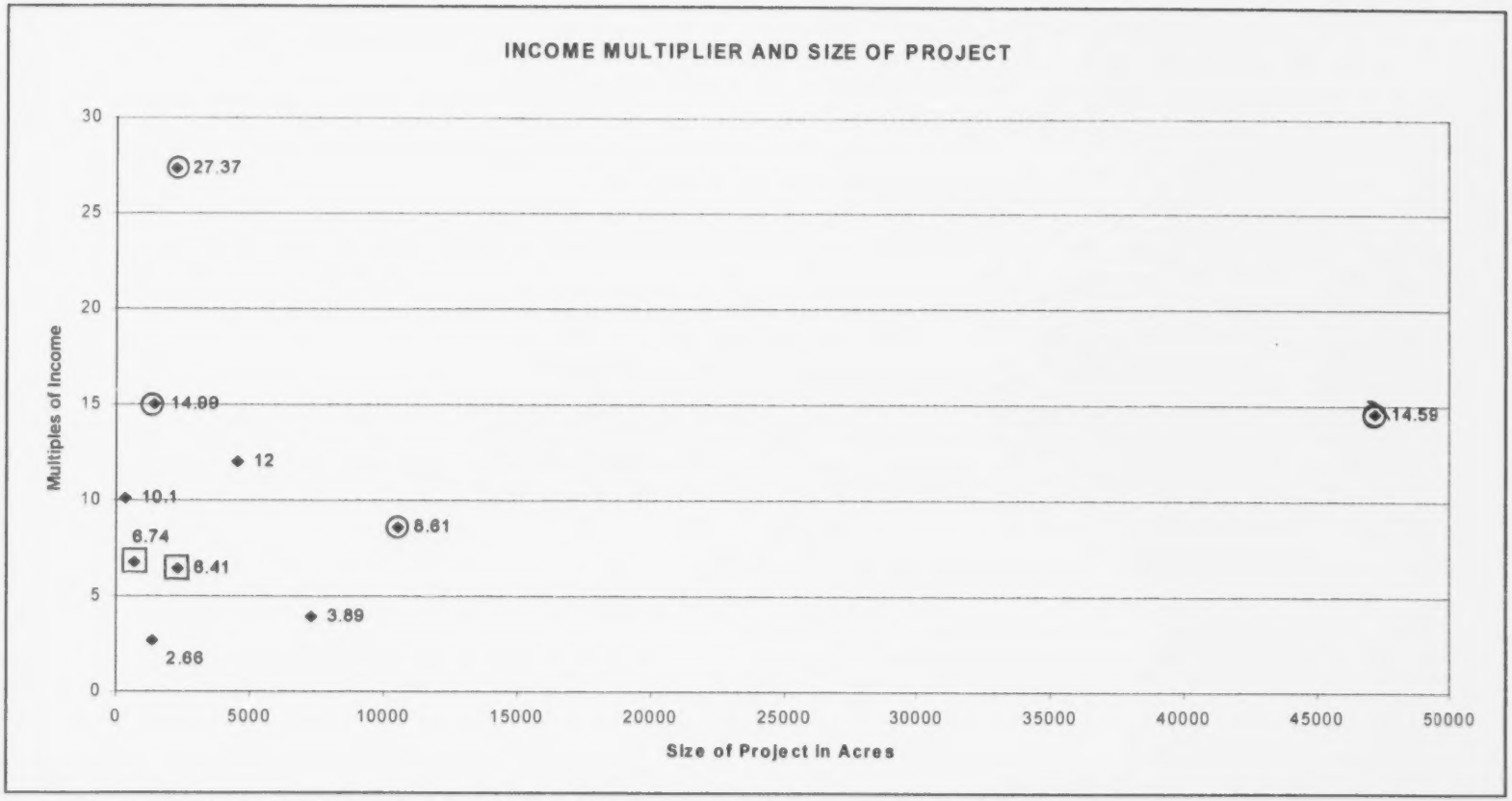


Figure 5.9: Relationship Between Investment Income Multiplier and Size of the Project

Results of the regression did not produce many significant determinant of economic contributions of a project. This may partly be because of the small sample size, or perhaps because some key variables are missing from those selected. The only variable that was significant and suggested a positive relationship with the multiplier activity was the ratio of farm level benefits and the construction cost of the project, both expressed on a per acre basis.

5.6 Social and Environmental Impacts of the Projects

Based on discussions with the Area Authorities for various sample projects, very little information was obtained. This information is presented in Table 5.3. Two aspects of environmental goods were reported in the survey -- wildlife and waterfowl habitats, and water quality. In all projects, impact on water quality was nil or positive. Impact on wildlife/waterfowl habitats were reported only by four Area Authorities.

Table 5.3: Wildlife / Waterfowl Habitat Impacts of Sample CDAA Projects

Project Name	Impact on Habitats	Impact on Water Quality
Aylsham Village	NO	NO
Brockington	YES (-)	NO
Trails End	NO	NO
Ranch Creek	YES (-)	NO
Hatke Lake	YES (+)	YES (+)
Leroy West	NO	NO
St. Gregor South*	NO	NO
Torquay West	NO	NO
Wiwa Creek	NO	NO
Green Lake	YES (-)	NO

* There are indications that this project site has lost some habitat but the extent of loss was not examined in this study due to data limitations.

This study cannot confirm or deny the authenticity of the responses shown in the Table 5.3. Naturally this requires a fresh investigation, involving an examination of the situation that existed before the project was implemented and comparing it against the present situation. Furthermore, past trends

in the wildlife/waterfowl population and other factors affecting these habitats also need to be taken into account.

5.7 Comparison of Study Results with Other Studies

Draining of farm lands is not a new activity. As early as 1859, French (1859) had developed procedure for farmers to follow for draining lands in the United States. Various Canadian provinces have also developed manual for farmers encouraging them to drain farm lands (See Manitoba Agriculture, 1973 and 1987, and Irwin, 1963).

Prescription for draining lands is basically based on the economic objectives of the farmers. The first and foremost criterion of the farmer is whether drainage would pay for itself over time. The most commonly quoted benefits of on-farm drainage include:

- Improvement in the yield of various crops, through improved crop growing conditions. Earlier spring seeding, warmer soils in spring, increased soil air in root zone, increased availability of nutrient, are some of the factors that result in higher crop yields.

- Particularly under period of high crop prices, higher yields translate into higher gross returns from the land. This improves probability of a poorly drained parcel of land being drained.

- The workable acreage of the farm is increased through drying up the wet areas.

- Good drainage also permits more efficient machine operations.

- Improved gross returns and cost savings result in higher expected benefits from the parcel of land.

- Livestock may be healthier due to drier footing conditions.

- Management is easier because all fields can now be placed in a rotation, resulting in higher yields.

- The cumulative impact of the above set of changes is that the property value of the farm is increased.

Although the above applies more to draining of poorly drained farm lands in general, many of these benefits are equally applicable to draining of land subject to frequent flooding.

Undrained lands provide a number of ecological and societal services. Ecological services include the maintenance of water quality, stability of water flow, provision of wildlife habitat, and location for

migratory stopover locations. Societal services include the provision of places for scenic appreciation, sites for recreation and tourism, and sources of local pride and prestige. For example, 4.4 million Canadians participated in wildlife viewing activities in 1996 (DuWors et al. 1999). In 1991, 19.1 million Americans participated on non-consumptive uses of waterfowl and shorebirds, focused largely in wetland areas, spending over $3.3 billion US (Southwick Associates 1995).

A preliminary (and thus far cursory) review of the literature indicates a relative dearth of studies in Canada, particularly in the context of on-farm benefits. Although relatively more studies have been undertaken for the social valuation of wetlands, many of these are in regions outside the Canadian prairies. Furthermore, most of these studies have cast these decisions in a benefit-cost mode, with a strict private accounting stance.

In the context of on-farm economics of draining wetlands, a Manitoba study by Norton and MacMillan (1970) indicated that on-farm benefits are enhanced on larger farms and by the presence of municipal drainage system. Distance to a water channel (such as the river) decreased the on-farm benefits but the estimated coefficient was not significant. A more recent study by Slevinsky and Schallenberg (1990) estimated the on-farm benefits from drainage on Morris and Osborne soils in the order to $11 per acre.

In Saskatchewan, a number of economic appraisals of flood control programs have been undertaken, although the reports are not available in a published format. Benefit cost ratio of 1.2 to 1.5 has been reported for the Beatty East Flood Control Project.[5]

Apedaile (1987) examined the surface and sub-surface type of drainage systems in Alberta and concluded that sub-surface drainage systems were not viable on many farms when all farm costs, benefits and taxes are included. At the same time, role of policies (particularly stabilization policies or insurance policies) to protect landowners against reduction in the benefit stream through market place or natural disasters was found to be significant. Both of these studies looked at the on-farm economics of drainage from the private accounting stance.

A somewhat balanced approach to valuation of wetland preservation in Ontario is reported by van Vuuren and Roy (1993). In this study all agricultural benefits were included, whereas social valuation included preservation benefits including hunting, angling and trapping. Social net values exceeded from conversion of that wetlands to agriculture. The difference between the two set of value estimates were a result of including subsidies to drainage, property taxes, and inability of the landowners to extract payment for all preservation benefits.

Recognition of off-farm benefits of wetlands is recognized by landowners. A recent survey of land owners in the Prairie provinces by Chorney and Josephson (2000) indicated that 156 of the 323 respondents to the survey fenced some of their surface water bodies, and provided no or little access

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[5] Based on a memo by M. T. McIntosh to V. Geissler, Saskatchewan Water Corporation, December 2, 1985.

to livestock. This shows some awareness on the part of land owners of benefits of maintaining and preserving such water bodies on their farm.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of the Study

This study has evaluated the economic efficiency and impacts of ten conservation and development projects constructed during the past 30 years in various areas of Saskatchewan. All of the projects received planning, technical and financial assistance from the provincial government to facilitate construction (i.e., most of the projects were constructed during a period of time when Saskatchewan Agriculture was responsible for administration of assistance for project design and construction; responsibility for these projects currently resides with SaskWater).

The projects were selected for analysis based on data submitted by Conservation and Development Area Authorities in a voluntary survey undertaken during the initial stage of this study. All of the projects have been operating and providing benefits to area farmers and residents for at least 15 years and in several cases as long as 30 years. The rationale for selecting projects with a lengthy period of operating experience was to provide sources of data on the flows over a period years of actual costs and benefits. Historic data were then projected into the future for the life of the project and converted to constant year 2000 dollars to provide consistency and comparability among projects for analytical and comparison purposes.

While not constituting a representative sample of the several hundreds of conservation and development projects existing in Saskatchewan, the projects examined in this study are illustrative of the characteristics, costs and benefits associated with the array of projects in the province. The projects in the sample are geographically dispersed across the province, approximately in proportion to the distribution of conservation and development projects in the various areas of the province. An example of this feature, is the similar concentration of projects in the northeast and east central regions of Saskatchewan.

The sample of projects examined are also illustrative of the main types of conservation and development projects existing in the province. For example, there are projects that are classified as single purpose drainage and flood control projects; some combine drainage and flood control features with a non-agricultural flood damage reduction features; others include back-flood irrigation features; and, one other project provides a lake stabilization feature combined with waterfowl and wildlife habitat enhancement features. There are no true multi-purpose projects in the sample but, when the projects are taken together, they illustrate most of the features that would exist in a multi-purpose project.

A spread-sheet based analytical model was developed as part of this study for the purpose of analyzing the economic efficiency and impacts of the projects. The model incorporated accepted conventional methodology for conducting benefit-cost analysis to measure project efficiency and input-output analysis for measuring direct and indirect economic impacts. Project data collected from the survey of area authorities underwent a process of clarification and refinement through follow-up

telephone interviews with representatives of area authorities and SaskWater. Data for each project were subjected to analysis utilizing the model and results compiled.

The analysis conducted in this study is called *ex poste* (or mid-term) analysis because it looks backward into time (and projects into the future) and examines the results of projects after they have been completed and in operation for many years. It examines whether results and impacts were consistent with typical expectations of efficiency and impact for such projects. The analysis provides answers to questions about whether the projects were worthwhile from the perspective of private beneficiaries as well as public beneficiaries, or society in general.

Several conclusions are reached on the basis of the analysis conducted in this study. The conclusions relate to the validity of the concept of conducting *ex poste* economic analysis; to the approach utilized and complexities of collecting reliable project data; to the methodologies employed in the economic analysis; to the model developed for conducting the analysis; and, to results of the analysis for individual projects and in aggregate.

6.2 Study Conclusions

The principle conclusions of this study are as follows:

1. The concept of conducting *ex poste* economic analysis of conservation and development project efficiency and impacts proved to be useful approach in this study but was limited in scope and reliability by data availability.

2. Use of a written survey with follow-up telephone contact was a satisfactory method for collecting the type of data needed the study. The major limitation of the survey was the low response rate due mainly to area authorities having to rely heavily on memory of members for the requested data.

3. The projects selected for detailed study does not comprise a representative sample of all conservation and development projects in Saskatchewan but they do constitute a set of pilot studies that effectively reflect project type and geographic distribution. The projects illustrate common project characteristics and key concepts and principles related to benefits and costs.

4. Combining project data provided by Area Authorities (e.g., project costs, investment time periods, etc.) with other data from secondary sources (e.g., crop yields, prices, etc.), while not perfect in terms of data quality, was an effective means of maximizing the usefulness of the analytical tools employed and of providing results for illustrative purposes.

5. The use of a spread-sheet based analytical model, incorporating the economic principles of benefit-cost analysis and input-output analysis was an excellent method for analyzing the efficiency and impacts of the projects. The methodology of meta analysis was a practical and valid way of aggregating the results of individual project analysis.

6. Methodologies developed, refined and applied in this study have a potential to be used in the future for planning and analytical studies on the efficiency and impacts of single and multi-purpose projects within the context of comprehensive watershed management. Decision criteria for project acceptance would consist of the key project performance and impact indicators utilized in this study.

7. Analytical results indicate that the projects studied, based on actual historic performance, have been relatively efficient in terms of utilization of private and public investment funds. In fact, based on the benefit-cost ration calculations, all projects were found to be economically desirable. Rates of return have been competitive with or better than other investment alternatives.

   - Based on the projects analyzed in this study, economic criteria suggest that these projects have been a good investment. All projects created additional wealth in the local area, primarily for the producers. On average, a project has added (or would add over its productive life) almost $1.2 million. Average benefit-cost ration for these projects is around 2.5, and the internal rate of return, on average, is 17%. These criteria suggest that for these projects, a decision to proceed with them was a good one. This remark should be interpreted carefully, since ecosystem benefits (or costs) have not been accounted for in this study.

   - Investment in these projects also brings forth major gains in income to the producers and other members of the society. On average, the projects studied contributed 10.74 times the money invested in these projects over their entire productive life.

8. Some projects presented better results than others with major differences associated with the type of project (i.e., multi-purpose projects tended to yield higher results) and the magnitude of benefitting land relative to cost (i.e., lower investment cost per acre yield higher results). Based on results obtained in this study, some of the projects with lower rates of return likely would not have been constructed or would have been designed differently.

9. Private benefits exceeded private and public costs in this study; however, the were several potential dis-benefits that could not be measured due to insufficient data (e.g., loss of waterfowl and wildlife habitat, etc.). It they could be effectively measured, social costs may challenge total benefits for certain projects.

10. Historically the projects studied have had significant direct and indirect employment and economic impacts on the local and provincial economies. These impacts will continue into the future stemming from incremental economic activity (e.g., agricultural production, investment, project operation and maintenance, etc.) generated by the projects.

    - Most of the projects did not indicate generation of benefits to third-parties, commonly called public goods. In fact, in these projects all benefits were captured by the private land holders or other institutions in the local (project) region.

6.3 Recommendations

Successful completion of this study required development of unique data collection techniques. It also required integrated use of primary and secondary data and creation of an innovative spread-sheet based model for conducting analysis consistent with application of sound economic principles. Based on experience gained in this study, several recommendations are provided to facilitate conduct of future similar studies with respect to conservation and development activities within the context of future watershed management activities.

Recommendations arising from this study are outlined as follows:

Recommendation 1

Administrators of future conservation and development projects should include a systematic data collection component to ensure that key indicators on project performance and impact can be reliably measured at various stages during the life of a project.

Availability of reliable data on project construction and operating costs as well as on bio-physical, economic and environment changes associated with the projects proved to be a major challenge. Data on construction activities and capital costs were difficult to access, without an extensive human resource search effort, because files were old, had been transferred within government agencies, were difficult to decipher, were incomplete or had been archived. Data on environmental impacts did not exist because environment impact assessments generally were not required when most of the projects were built.

Data on project operation and maintenance activities and costs were not readily available from many area authorities because the organizations operate on a volunteer basis and not much time is spent in maintaining files. When files are transferred between area authority secretaries data often tend to be misplaced. Information and data on farming systems and production costs on farm land within project land areas, both before and after the projects were built, was found not to exist. It was necessary to rely, in this study, on secondary sources for data on farming practices, crops, rotations, yields for municipalities in which the projects are located.

It is further recommended that an ex ante appraisal of the project be undertaken by the Area Authority proposing the project. This will further ensure that proper data have been collected.

Recommendation 2:

A systematic database should be established and maintained within a one Saskatchewan government agency, in cooperation with the Saskatchewan Conservation and Development Association, to retain data collected on critical performance measurement indicators selected for future conservation and development projects.

Because of a dearth of pertinent data, a survey instrument was developed for this project to collect data required to conduct the study. Not many area authorities participated in the survey because historic project data either did not exist, because area authority officials did not have sufficient confidence in the reliability of data that they did have or because they did not have access to data that might have been in SaskWater files.

In summary, reliable data for conducting the economic analysis undertaken in this study could not be obtained from original sources because of the historic nature of the data and the type of paper-based data filing system utilized in the past. No original economic feasibility study was found for any of the projects studied.

If a suitable performance measurement database (i.e., computerized) were in existence for conservation and development projects it would largely have been unnecessary to conduct the survey undertaken in this study. While it likely still would have been necessary to collect some information through survey (e.g., pre-project conditions, economic development spin-offs, etc.), an effectively designed project database could have provided most of the information and data needed for conducting the analysis. At the same time, maintenance of the project database would likely require small periodic surveys of area authorities to update information on project operation and impacts.

Follow-up taken over the longer term with respect to this recommendation should be linked with potential follow-up on the first recommendation. Designing and collecting selected project performance measurement data should be accompanied by a systematic computerized database management system.

Recommendation 3:

The survey instrument developed in this study could be used for monitoring the performance of a given project at frequent intervals to update data records and support economic impact evaluation of existing conservation and development projects.

This study included design of a comprehensive survey instrument to collect pertinent data on the different classes of conservation and development projects in existence. The survey consists of questions on base line information such as the rationale for the project, and data on capital and operating costs. It also contains questions in different parts of the survey related to benefits and impacts arising from single or multi-purpose projects (e.g., drainage and flood control, back-flood irrigation, lake stabilization, multi-purpose).

A completed survey form, supplemented with follow-up telephone contact to clarify some responses, provides a good profile of the characteristics of a particular conservation and development project. Development of the survey was essential for conducting this economic impact study but it can have ongoing usefulness beyond the scope of this study. The form can be completed by area authorities at any time and by comparing data with other projects

analyzed in this study can be potentially quite a useful tool in supporting on-going project management activities.

Recommendation 4:

The analytical model developed in this study could be readily adapted to facilitate future comprehensive watershed planning and management initiatives and to support multi-purpose project feasibility and impact analysis.

The methodology employed in this study included development of an analytical model, or tool, for conducting economic efficiency and impact analysis. The model utilizes a series of linked spread sheets for inputting and processing data, and presenting results. The outputs of the model are various measures of project efficiency (e.g., benefit-cost ratios, internal rates of return, net present values) and of economic impact (e.g., change in provincial sales, gross domestic project, personal income imports and employment).

While the model must be adjusted and customized to accommodate the unique features of each project, the principle steps involved in the calculations are the same for every project. Thus, the model can be adapted to conduct analysis of projects with many different types of agricultural and non-agricultural features.

A major advantage of the model is that it can be utilized for project planning purposes. Once it has been adapted to incorporate the features of a particular project (e.g., infrastructure to support agriculture, waterfowl and recreation) it can be used to conduct sensitivity analysis of changes in underlying assumptions or alternative project designs. In this capacity, the model could be especially useful for facilitating future studies of multi-purpose projects within the context of watershed planning activities.

Recommendation 5:

The Saskatchewan Conservation and Development Association and an appropriate provincial government agency should consider alternatives for communicating and sharing with others information developed in this study about the benefits and impacts of conservation and development projects.

This results of this study indicate that conservation and development projects examined have had generally positive impacts on local farming operations in terms of reduced flooding and improved cropping. Quantitative data on agricultural benefits and impacts as well as estimated rates of return on investment are the types of information that would be of interest to local farmers and rural municipalities. This and other information could be useful to newspapers and others in preparing articles on success stories in rural Saskatchewan.

The information could also facilitate more informed, positive discussions in the future with representatives of other resource management and environmental interest groups. It is evident from results of the analysis that there are significant economic advantages, in terms of both private and societal interests, in working towards design of multi-use projects within the context of comprehensive watershed management.

The study illustrates examples of economic costs incurred by farmers if projects are not undertaken (i.e., foregone economic benefits of conservation and development projects). Examples also illustrates the potentially broader range and magnitude of benefits possible when farmers and other interest groups work together towards optimal management of scarce water resources.

Recommendation 6:

Although this study is based on a small sample, it does point out to some important guidelines. These guidelines are recommended for consideration of future water control projects:

- Projects should be subjected to an *ex ante* appraisal. Such an appraisal should encompass economic, social and environmental impacts of the project. To the extent possible, both economic efficiency and impacts related criteria should be included. Economic efficiency measures must also include non-economic impacts of the project.

- Water control projects that provide benefits (or at the same time do not destroy environmental services in the region) beyond the farm gates should be given a higher priority. This purpose would be best served through development of multi-purpose projects, which produce a range of private and public goods.

- Project capital and operating costs for water control projects should be shared commensurate with the ratio of public and private benefits generated by the project. If a project does not generate any direct public goods, it should not qualify for support by the public sector.

PART B

SASKATCHEWAN CONSERVATION AND DEVELOPMENT PROJECT CASE STUDIES

7.0 AYLSHAM VILLAGE PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Aylsham Village project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in the various sections of this chapter.

7.1 Description of Project

The Aylsham Village project is operated by the Nipawin Conservation and Development Area Authority No. 101. The project is located in the village of Aylsham and is classified as a drainage and flood control project. The purpose of the project was to reduce flooding problems in the village and on up-stream farmlands. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated by the village of Aylsham in 1979.
The major activities undertaken through the project were widening and deepening of an existing drainage channel, construction of a railway bridge with associated drop inlets and relocation of utilities. The immediate project area involves 15 acres primarily within the village. The assessed area for purposes of project planning and operation consists of 47,166 acres, the area that land surveys indicated would benefit from improved drainage resulting from the project.

7.1.1 Conditions Prior to the Project

The Area Authority[6] reported that the situation prior to the project consisted of regular annual flooding in the village and onto adjacent lands as a result of excessive spring water run off from farmlands in the up-stream drainage area. The problems reported by farmers due to slow water run off in the up-stream drainage area were as follows:

- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness;
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

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6 In this and subsequent discussions, the Area Authority refers to the local Conservation and Development Area Authority.

The flooding problem in the village was created, in part, by construction of unregulated drainage channels on up-stream farmlands over the years prior to implementation of the project. The location of the railroad bed also caused water back-up and the small size of the existing channel prevented the excess water from properly draining through the village.

The Area Authority estimated that 20 households in the village experienced some degree of annual flooding in the years leading up to the project. The flooding of basements and more serious problems in some years occurred when the water overflowed the banks of the under-sized drainage channel.

7.1.2 Changes Arising from the Project

Both agricultural and non-agricultural benefits were identified as arising from the bio-physical changes associated with improved water management under the project. The primary agricultural benefits are reflected in production of more valuable crops due to earlier seeding; improved crop yields and quality due to more timely seeding and better weed control; and, cost savings associated with more efficient machinery operation around low lands. The primary non-agricultural benefits were associated with reduced flooding damage in the village of Aylsham and improved recreation potential within the village from nature walks along the channel and winter sports (e.g., skating) on the channel.

Estimates of the value of agricultural benefits and flood damage reduction benefits are calculated for the Aylsham project based on the assumptions outlined in the next section.

7.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

7.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 7.1. Total construction costs in current dollars were $309,000. Construction occurred in two phases, beginning in 1986 and finishing in 1989.

Under Phase I, $222,000 was invested in 1986 and 1987 in obtaining right-of-way, earthmoving to widen and deepen the channel, construction of a new railway bridge over the channel and relocation of utilities. Under Phase 2, $78,000 was invested in 1988 and 1989 in construction of railway drop inlets to control channel water levels and completion of landscaping. The value of the capital investment in constant year 2000 dollars is estimated

to be $401,530. The salvage value of project works is estimated to be $80,306 in constant year 2000 dollars.

Table 7.1: Time Period & Amount of Construction Expenditures, Aylsham Village Project

Year	Activity	Expenditures
1980	Design and Surveys	$9,000
1981-85	Project design completed	
1986	Construction Phase 1	$100,000
1987	Construction Phase 1	$122,000
1988	Construction Phase 2	$13,000
1989	Construction Complete	$65,000
	(Benefit flows begin)	
Total - current dollars		$309,000
Total - constant year 2000 dollars		$401,530

7.2.2 Operation and Maintenance Costs

The first year of project operation was 1989. The expected life of project operation after completion of construction is estimated to be 40 years (i.e., 1989 to 2029). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2029 are $48,110 in current dollars and $54,539 constant year 2000 dollars.

7.2.3 Agricultural Benefits

The agricultural benefits resulted from improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield change with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that without the project, the crop yield equivalent was below average by 5 to 10% due to poor drainage before the project. The lower yield estimate of 5% below average was used in this analysis. Based on actual farming experience during the 1989 to 2000 period after completion of project construction, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area.

The Area Authority also indicated that the yield equivalent changes have been accomplished with no identified input cost increases other than those associated with technology change. Cost savings resulting from improved machinery utilization have offset any input cost increases above those associated with technology change.

Crop production costs were based on the normalized cost of production formula developed in this study to internalize agricultural technology changes. During the time period that benefits flowed from this project, farming technology has gradually changed from conventional tillage to a high proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, the technology change formula and fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola. No incremental livestock benefits were identified for the project.

7.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

The value of recreational activities associated with stabilization of water flows through the village channel could not be estimated due to insufficient data on the actual magnitude of actual recreational activity.

Estimates of flood damage reduction are based on data from the Area Authority that 20 homes in the village were flooded annually, on average, prior to project construction and no homes have been flooded since completion of the project. The cost of flood damage was estimated at $3,000 per home per year based on the cost of pumping out basements, repairing flood damage and the commercial value of families living outside their home for two weeks per year during the period of flooding, flood damage repair and clean up.

7.3 Results of Analysis

The results of the analysis for the Aylsham Village conservation and development project are summarized in Table 7.2. In addition, a number of other indicators were also created for the project. These included the capital cost perp acre, net benefits from farm production, and economic development multipliers.

7.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $5.54 and $7.22 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $2.5 million based on a 5% discount rate and $0.7 million based on a 10% discount rate for the base year crop prices. Net present values are slightly higher for 10-year average crop prices.

The benefit-cost ratios are 4.14 and 2.88 respectively for 5% and 10% discount rates for base year prices and slightly higher for 10-year average crop prices. The internal rate of return is estimated to be 31.59% based on base year crop prices and 33.08% for 10-year average crop prices.

7.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $3.3 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $3.1 million while the increase in full-time equivalent employment is 51 person-years. All economic impacts are slightly higher for 10-year average crop prices and are significantly lower for a 10% discount rate, except employment which remains constant.

Economic development multipliers for the project per dollar of investment are $2.51 for sales, $12.49 for the provincial gross domestic project and $11.49 for personal income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, personal income, for example, increases in total over the life of the project by 11.49 times.

Table 7.2: Summary of Indicators, Aylsham Village Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$401.53	
Capital cost/acre	$ constant (2000)	$6.55	
Area affected	Acres	47166	
New Area Created (Maturity)	Acres	47166	
Weighted benefits/acre	$	$5.54	$7.22
Net Present Value -- 5%	$1,000	$2,461.84	$2,933.16
Net Present Value -- 10%	$1,000	$720.41	$953.33
Benefit-Cost Ratio	5%	4.14	4.39
	10%	2.88	3.06
Internal Rate of Returns	%	31.59%	33.08%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$672.95	$901.20
Gross Domestic Product	1,000 $	$3,348.53	$4,256.16
Income	1,000 $	$3,078.65	$3,911.61
Imports	1,000 $	$296.47	$319.38
Employment	FTE Jobs	51	66
Present value at 10%			
Sales	1,000 $	$407.71	$485.24
Gross Domestic Product	1,000 $	$1,233.74	$1,542.03
Income	1,000 $	$1,108.27	$1,391.19
Imports	1,000 $	$144.77	$152.55
Employment	FTE Jobs	51	66
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$2.51	$3.36
Gross Domestic Product		$12.49	$15.88
Income		$11.49	$14.59

8.0 BROCKINGTON PROJECT

This chapter contains a description of the Brockington project, and the results of economic efficiency and economic impacts resulting from it. A description of assumptions employed for purposes of the evaluation are also outlined in this chapter.

8.1 Description of Project

The Brockington Flood Control project is operated by the Lund Conservation and Development Area Authority No. 75. The project is located northeast of Melfort, within the Rural Municipality of Kinistino No. 459, centered in Townships 47 and 48 and Ranges 19 and 20, west of the 2nd Meridian. The project is classified as a drainage and flood control project. The purpose of the project was to reduce flooding problems on up-stream farmlands. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems began in 1976.

This project was selected as the initial pilot project under this study because it was considered to be a typical Rural Water Control Program assisted flood control and drainage project involving agricultural land. SaskWater staff provided data on project construction and operating costs as well as relevant dates for project construction.

A meeting was held by the study team members and SaskWater officials with representatives of the Lund CDAA in Melfort on February 2, 2001 to discuss the project. The session resulted in excellent responses to a series of questions related to pre- and post-project land use and drainage conditions; project construction and operation costs; changes in crop rotations, farming practices and crop yields associated with the project; as well as other external technical, social of environmental effects associated with the project. The information derived from this focus group session was used to refine questions for the CDAA survey guide used for obtaining data on other projects.

The major work undertaken through the Brockington project was construction of a system of 22 miles of new or improved primary and secondary drainage ditches, drop control structures and road crossings. The network was designed to expedite and control the annual surface run-off from sloughs and other low lands towards the Saskatchewan River, thereby facilitating earlier spring cultivation and introduce other efficiencies in farming operations. The assessed area for purposes of project planning and operation consists of 7,324 acres, the area that land surveys indicated would benefit from improved drainage resulting from the project.

8.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of periodic flooding due to spring runoff and seasonal rains. About 2,197 acres were flooded throughout

the project area, creating this area to be unsuitable for crop production at a frequency of about 8 years out of 10. An additional 10% of the land area adjacent to the flooded areas (or about 734 acres) was subject to salinity and also produced little to no crop. These flooded areas were infested with slough weeds and foxtail during drier years.

The problems reported by farmers due to slow water run off in the upland drainage area were as follows:

- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Soils in the project area are rated primarily Canada Land Inventory Classes 1 and 2, limited by excess water and poor drainage. Thus, the lands had potential for productivity improvement through planned water control and drainage.

8.1.2 Changes Arising from the Project

Agricultural benefits are identified as arising from the bio-physical changes associated with improved water management under the project. The primary agricultural benefits are reflected through incremental crop production on land area reclaimed from flooding, production of more valuable crops due to earlier seeding; improved crop yields and quality due to more timely seeding and better weed control; and, cost savings associated with more efficient machinery operation around low lands.

Non-agricultural benefits included improved wildlife and waterfowl habitat along ditches (e.g., 3.5 acres per mile) and local employment generated from construction and operation of the project. Very minimal negative downstream impacts were identified.

Estimates of the value of agricultural benefits are calculated for the Brockington project based on assumptions outlined in the next section.

8.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

8.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 8.1. Total construction costs in current dollars were $567,328. Construction of the main ditch occurred in 1982 and 1983. Construction of the laterals was undertaken from 1984 to 1989. Agricultural production benefits began to flow in 1985 from the first laterals constructed.

Table 8.1: Time Period and Amount of Construction Expenditures, Brockington Project

Year	Activity	Expenditures
1978	Design and Surveys	$19,770
1982	Construction - Main Ditch	$29,433
1983	Construction contd.	$203,710
1984	Construction - Laterals	$192,072
1985	" (Benefit flows begin)	$55,680
1986	Some construction contd.	$16,050
1987	Some construction contd.	$41,170
1988	Some construction contd.	$6,793
1989	Construction Complete	$2,650
Total - current dollars		$567,328
Total - constant year 2000 dollars		$803,897

The value of the capital investment in constant year 2000 dollars is estimated to be $803,897. The salvage value of project works is estimated to be $229,909 in constant year 2000 dollars.

8.2.2 Operation and Maintenance Costs

The first year of project operation was 1985. The expected life of project operation after completion of construction is 40 years (i.e., 1989 to 2029). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and

then projected to 2029 are $236,415 in current dollars and $259,598 constant year 2000 dollars.

8.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from crop production on reclaimed land area as well as improvements in cropping patterns, crop yields, crop quality and reduced costs on upland crop area. The land area reclaimed totaled 2,197 acres and resulted from reduction in the land area subject to flooding and salinity.

For the upland areas, it was determined from the focus group meeting with the Area Authority, that estimation of improvements for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield change with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that the crop yield equivalent on the upland crop area of 4,393 acres was about 10% below the area average due to poor drainage before the project. Based on actual farming experience during the 1985 to 2000 period after completion of project construction, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the project area.

The Area Authority also indicated that the yield equivalent changes have been accomplished with no identified input cost increases other than those associated with technology change. Cost savings resulting from improved machinery utilization have offset any input cost increases above those associated with technology change.

Crop production costs were based on the normalized cost of production as estimated by Saskatchewan Agriculture and Food (2002). During the time period that benefits flowed from this project, farming technology gradually changed (from conventional to conservation tillage) and increased incorporation of specialty crops, especially pulse crops, into crop rotations was noticeable. To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations were used for analysis of this project. The crop rotation consisted of 25% wheat, 25% canola, 25% barley and 25% field peas, with costs adjusted according to the technology change formula. No incremental livestock benefits were identified for the project.

8.2.4 Non-Agricultural Benefits

Due to absence of suitable data, no quantitative estimates of the value of non-agricultural benefits in the form of improved wildlife and waterfowl habitat along ditches (e.g., 3.5 acres

per mile) were undertaken. Calculation of local employment impacts generated from construction and operation of the project are included in section on economic impact analysis.

8.3 Results of Analysis

The results of the analysis for the Brockington conservation and development project are summarized in Table 8.2.

8.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $23.48 and $23.20 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $773,650 based on a 5% discount rate and $29,230 based on a 10% discount rate for the base year crop prices. Net present values are slightly lower for 10-year average crop prices.

The benefit-cost ratios are 1.64 and 1.04 respectively for 5% and 10% discount rates for base year prices and slightly lower for 10-year average crop prices. The internal rate of return is estimated to be 10.50% based on base year crop prices and 9.81% for 10-year average crop prices.

8.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $2.7 million at a 5% discount rate based on base year crop prices. On the same basis, the estimated life-time increase in net income is $1.8 million while the increase in full-time equivalent employment is 229 person-years. All results are slightly higher for 10-year average crop prices and significantly lower for a 10% discount rate, except employment which remains constant.

Economic development multipliers for the project per dollar of investment are $6.86 for sales, $4.83 for the provincial gross domestic project and $3.17 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, personal income, for example, increases in total over the life of the project by 3.17 times.

Table 8.2: Summary of Indicators, Brockington Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$803.90	
Capital cost/acre	$ constant (2000)	$77.46	
Area affected	Acres	7324	
New Area Created (Maturity)	Acres	2197.2	
Weighted benefits/acre	$	$23.48	$23.20
Net Present Value -- 5%	$1,000	$773.65	$701.41
Net Present Value -- 10%	$1,000	$29.32	$-11.66
Benefit-Cost Ratio	5%	1.64	1.58
	10%	1.04	0.98
Internal Rate of Returns	%	10.50%	9.81%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$3,883.00	$4,597.22
Gross Domestic Product	1,000 $	$2,731.57	$3,336.03
Income	1,000 $	$1,792.07	$2,198.04
Imports	1,000 $	$974.19	$1,113.82
Employment	FTE Jobs	229	298
Present value at 10%			
Sales	1,000 $	$2,011.46	$2,294.31
Gross Domestic Product	1,000 $	$1,334.79	$1,574.18
Income	1,000 $	$879.83	$1,040.61
Imports	1,000 $	$481.57	$536.87
Employment	FTE Jobs	229	298
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$6.86	$8.13
Gross Domestic Product		$4.83	$5.90
Income		$3.17	$3.89

9.0 TRAILS END PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Trails End project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

9.1 Description of Project

The Trails End project is operated by the Torch River Conservation and Development Area Authority No. 65. The project is located in township 53, range 14W2nd in the Rural Municipality of Torch River No. 488. and is classified as a drainage and flood control project. The purpose of the project was to reduce flooding problems on the affected farm lands due to spring run off and heavy summer rains. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated by the Area Authority in 1975.

The major activities undertaken through the project were construction of an earthen drainage ditch, installation of culverts and drop structures, and acquisition of right-of-way. Some of the construction was on property owned by the rural municipality. The total area included within the boundaries of the project is 4,560 acres. A total of 3,924 acres are assessed for project planning and operation purposes, the area that land surveys indicated would benefit from improved drainage resulting from the project.

9.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of frequent annual flooding of the affected farm lands. Spring and summer flooding typically affected the best land in the area. Farmers found the time factor of going around the water runs to access land areas to seed, delayed seeding and often not seeding to be significant problems in effective management of the land resource and crop rotations. The flooded land area would typically be summerfallowed to control weed growth once the wet land became dry enough to access with farm equipment.

Problems reported by farmers due to flooding and slow water run off in the up-stream drainage area are summarized as follows:

- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness and salinity;

- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Slough land area totaled 732 acres on which 100% yield losses typically occurred at an estimated frequency of 9 years out of 10. An additional 800 acres experienced severe yield reductions of up to 30% below the area average due to a combination of the foregoing factors. Moderate yield losses of up to 10% below area average yields occurred on 3,028 acres due primarily to the impacts of delayed seeding.

9.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits are identified as arising from the bio-physical changes associated with improved water management under the project. Flooding from spring and summer water run-off has been substantially reduced from installation and use of the project drainage works.

Primary agricultural benefits accrue directly to local area farmers and the agricultural sector. Agricultural benefits are reflected in production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Through the construction of the project, more and better quality cultivated land has been made available for cropping on a regular basis and, overall, crop yields have increased because of the longer growing season associated with dryer soil conditions. The Area Authority reported that area farmers agree they would do the project again because there has been so much benefit to local agriculture.

The primary non-agricultural benefits are associated with indirect impacts of construction and operation of the project on the local and provincial economy.

Estimates of the value of agricultural benefits are calculated for the Trails End project based on assumptions outlined in the next section.

9.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

9.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 7.1. Total construction costs in current dollars were $240,979. Construction occurred during the 1981 and 1982 seasons.

Table 9.1: Time Period and Amount of Construction Expenditures, Trails End Project

Year	Activity	Expenditures
1976	Survey	$25,300
1977		
1978		
1979		
1980	Construction	$107,839
1981	Construction Complete	$107,839
1982	(Benefit flows begin)	
Total - current dollars		$240,979
Total - constant year 2000 dollars		$415,816

A total of $140,789 was invested in earthmoving to construct the drainage channel and $3,600 spent for acquisition of right-of-way. A total of $21,301 was used for installation of culverts, $48,947 for construction of drop structures and the balance of $1,041 used for completion of landscaping. The value of the capital investment in constant year 2000 dollars is estimated to be $415,816. The salvage value of project works is estimated to be $107,362 in constant year 2000 dollars.

9.2.2 Operation and Maintenance Costs

The first year of project operation was 1982. The expected life of project operation after completion of construction is 50 years (i.e., 1982 to 2031). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2031 are $52,113 in current dollars and $57,793 constant year 2000 dollars.

9.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from reclamation of flooded slough land, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that the crop yield equivalent was below area average by up to 30% for land severely affected by poor drainage and up to 10% below area average for land moderately affected by poor drainage before the project. Based on actual farming experience during the 1982 to 2000 period after completion of project construction, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land the yield improvement is 100%; for severely affected land the yield improvement is 30%; and, for moderately affected land the yield improvement is 10%.

It was assumed that the yield equivalent improvements required a 50% increase in fertilizer costs for severely affected land and a 25% increase in fertilizer costs for moderately affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production as provided by Saskatchewan Agriculture and Food (2002). During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola with adjustments to cost to reflect changing technology towards increased conservation tillage.. No incremental livestock benefits were identified for the project.

9.2.4 Non-Agricultural Benefits

Calculation of local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

9.3 Results of Analysis

The results of the analysis for the Trails End conservation and development project are summarized in Table 9.2.

9.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $11.71 and $11.63 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $468,790 based on a 5% discount rate and $344,740 based on a 10% discount rate for the base year crop prices. Net present values are slightly lower for 10-year average crop prices.

The benefit-cost ratios are 2.39 and 1.28 respectively for 5% and 10% discount rates for base year prices and slightly lower for 10-year average crop prices. The internal rate of return is estimated to be 12.65% based on base year crop prices and 11.11% for 10-year average crop prices.

9.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $4.8 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $3.8 million while the increase in full-time equivalent employment is 162 person-years. All results are slightly higher for 10-year average crop prices and slightly lower for a 10% discount rate.

Economic development multipliers for the project per dollar of investment are.$15.68 for sales, $14.86 for the provincial gross domestic project and $11.73 for income, based on base year crop prices. The multipliers are slightly higher for 10-year average crop prices. These ratios mean that for every $1 dollar invested in the project, provincial gross domestic product, for example, increases in total over the life of the project by $14.86, or about 15.0 times the investment value.

Table 9.2: Summary of Indicators, Trails End Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$415.82	
Capital Cost per acre	$ constant (2000)	$52.85	
Area affected	Acres	4560	
New Area Created (Maturity)	Acres	732	
Weighted benefits/acre	$	$10.95	$11.63
Net Present Value -- 5%	$1,000	$405.76	$395.22
Net Present Value -- 10%	$1,000	$316.06	$302.36
Benefit-Cost Ratio	5%	2.2	2.17
	10%	1.17	1.12
Internal Rate of Returns	%	11.64%	11.11%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$5,054.50	$5,078.58
Gross Domestic Product	1,000 $	$4,791.65	$4,887.41
Income	1,000 $	$3,782.60	$3,870.49
Imports	1,000 $	$699.69	$702.11
Employment	FTE Jobs	162	164
Present value at 10%			
Sales	1,000 $	$2,370.20	$2,377.18
Gross Domestic Product	1,000 $	$2,153.69	$2,181.47
Income	1,000 $	$1,688.80	$1,714.30
Imports	1,000 $	$329.85	$330.55
Employment	FTE Jobs	162	164
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$15.68	$15.75
Gross Domestic Product		$14.86	$15.16
Income		$11.73	$12.00

10.0 RANCH CREEK PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Ranch Creek project using the benefit-cost analysis and input-output model. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

10.1 Description of Project

The Ranch Creek project is operated by the St. Peter Conservation and Development Area Authority. The project is located in the Rural Municipality of St. Peter No. 369 and the Rural Municipality of Lake Lenore No. 399. The project is classified as a drainage and flood control project but with a significant drainage water containment purpose. The purpose of the project was to reduce flooding and salinity problems by increasing the capacity of an existing drainage channel to better contain increased quantities of drainage water flowing through the system from upstream land areas. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated with a petition by area farmers in 1986.

The major activities undertaken through the project were widening and deepening of an existing drainage channel, construction of bridges and culverts, and installation of drop structures. The assessed area for purposes of project planning, construction and operation consists of 35,000 acres. This is the up-stream water run-off area that land surveys indicated contributed to flooding and increased salinity problems along the 8-mile existing drainage channel.

10.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of frequent annual flooding of adjacent land along the existing drainage ditch. The flooding was caused by private drainage water movement from up-stream farm lands. Flooding and high water contributed to build-up of salinity for about one-quarter mile on either side of the 8 mile ditch. The problems reported by farmers along the ditch and in the up-stream drainage area were as follows:

- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;

- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Up-stream slough land area totaled 1,094 acres on which 100% yield losses typically occurred at an estimated frequency of 8 years out of 10. An additional 2,560 acres on either side of the ditch experienced severe yield reductions of up to 15% below the area average due to a combination of the foregoing factors. Barley was typically grown on the soil affected by salinity.

10.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits are identified as arising from the bio-physical changes associated with improved water management under the project. Widening and deepening of the ditch has increased capacity and substantially reduced flooding from spring and summer water run-off both along the ditch and in the up-stream farming area. Salinity along the channel has been significantly reduced through more timely water management made possible by the project.

Primary agricultural benefits have accrued directly to local area farmers and the agricultural sector. Agricultural benefits are reflected in production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

More and better quality cultivated land was reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity. No incremental benefits were observed on the remaining higher land areas. The Area Authority reported that drainage complaints were alleviated by development of this project.

The primary non-agricultural benefits were associated with indirect impacts of construction and operation of the project on the local and provincial economy.

10.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project. These subsequently became the basis for economic efficiency analysis and economic impact assessment.

10.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 10.1. Following completion of survey and design work, project construction began in 1987, continued over the following years and was completed in 1993.

Table 10.1: Time Period and Amount of Construction Expenditures, Ranch Creek Project

Year	Activity	Expenditures
1986	Survey Begins	
1987	Survey Ends/Construction	$39,500
1988	" (Benefit flows begin)	$43,400
1989	"	$105,900
1990	"	$19,300
1991	"	$52,300
1992	"	$12,300
1993	Construction Complete	$600
Total - current dollars		$273,300
Total - constant year 2000 dollars		$345,610

Funds were invested in earthmoving to widen and deepen the existing channel, for installation of culverts and bridges and for construction of drop structures. An estimated 75% of the expenditures were invested within 50 miles of the project. Most of the balance was spent elsewhere in Saskatchewan.

Total construction costs in current dollars were $273,300. The value of the capital investment in constant year 2000 dollars is estimated to be $345,610. The salvage value of project works is estimated to be $69,122 in constant year 2000 dollars.

10.2.2 Operation and Maintenance Costs

The first year of project operation was 1988. The expected life of project operation after completion of construction is 20 years (i.e., 1993 to 2013). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2013 are $78,918 in current dollars and $80,181 constant year 2000 dollars.

10.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from reclamation of flooded slough land, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that crop yield equivalents were below area average yields by up to 15% for land severely affected by poor drainage and up to 10% below area average for land moderately affected by poor drainage before the project. Based on actual farming experience during the 1988 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land of 1,094 acres the yield improvement is 100%; and, for the severely affected land area of 2,560 acres the yield improvement is 15%.

It was assumed that the yield equivalent improvements required a 33% increase in fertilizer costs for severely affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production data obtained from Saskatchewan Agriculture and Food (2002). Due consideration was made in this study to internalize agricultural technology changes. During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola with adjustments in cost to reflect changing technology towards increased conservation tillage.. No incremental livestock benefits were identified for the project.

10.2.4 Non-Agricultural Benefits

Calculation of local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

10.3 Results of Analysis

The results of the analysis for the Ranch Creek conservation and development project are summarized in Table 10.2.

10.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $27.15 and $28.80 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $$512,970 based on a 5% discount rate and $207,860 based on a 10% discount rate for the base year crop prices. Net present values are slightly higher for 10-year average crop prices.

The benefit-cost ratios are 2.41 and 1.68 respectively for 5% and 10% discount rates for base year prices and slightly higher for 10-year average crop prices. The internal rate of return is estimated to be 20.98% based on base year crop prices and 22.30% for 10-year average crop prices.

10.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $3.9 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $2.8 million while the increase in full-time equivalent employment is 88 person-years. All results are slightly lower for 10-year average crop prices, except for sales and imports which are higher. All results are lower for a 10% discount rate.

Economic development multipliers for the project per dollar of investment are $18.92 for sales, $13.84 for the provincial gross domestic project and $10.10 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, total sales of all goods and services, for example, increase in total over the life of the project by 18.9 times.

Table 10.2: Summary of Indicators, Ranch Creek Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$345.61	
Capital cost/acre	$ constant (2000)	$135.00	
Area affected	Acres	0	
New Area Created (Maturity)	Acres	312.57	
Weighted benefits/acre	$	$27.15	$28.80
Net Present Value -- 5%	$1,000	$512.97	$561.01
Net Present Value -- 10%	$1,000	$207.86	$234.76
Benefit-Cost Ratio	5%	2.41	2.55
	10%	1.68	1.77
Internal Rate of Returns	%	20.98%	22.30%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$5,292.07	$5,530.16
Gross Domestic Product	1,000 $	$3,870.98	$3,396.35
Income	1,000 $	$2,824.52	$2,261.52
Imports	1,000 $	$822.67	$939.29
Employment	FTE Jobs	88	53
Present value at 10%			
Sales	1,000 $	$3,084.81	$3,528.04
Gross Domestic Product	1,000 $	$2,198.47	$2,152.57
Income	1,000 $	$1,589.37	$1,434.44
Imports	1,000 $	$493.09	$602.03
Employment	FTE Jobs	88	53
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$18.92	$19.78
Gross Domestic Product		$13.84	$12.14
Income		$10.10	$10.10

11.0 HATKE LAKE PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Hatke Lake project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

11.1 Description of Project

The Hatke Lake project is operated by the Hatke Lake Conservation and Development Area Authority. The project is located in the Rural Municipality of Leroy No. 339. It is classified as a drainage and flood control project with a significant multi-purpose feature. The purposes of the project were to reduce flooding problems on up-land farmlands adjacent to Hatke Lake; and, to stabilize water levels in Hatke Lake and associated habitat to permanently accommodate waterfowl and wildlife in the area. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated with a petition by area farmers in 1975.

The major activities undertaken through the project were construction of 7 miles of ditch, installation of culverts and crossings as well as construction of flax straw drop structures to control water erosion in the drainage channel. The assessed area for purposes of project planning and operation consisted of 10,544 acres, while the area assessed for construction was 7,353 acres, land area that surveys indicated would benefit from improved drainage resulting from the project.

11.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of periodic annual flooding of farmlands due to excessive water from spring run-off and summer rains flowing into Hatke Lake from farmlands adjacent to the lake and in the up-stream drainage area. The problems reported by farmers due to poor drainage and flooding were as follows:

- Loss of production from flooded land and salinity;
- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to Hatke Lake and upland sloughs; and,

- Reduced machinery operation efficiency due to excessive turning around low areas.

Land area adjacent to Hatke Lake and upstream land area totaled 830 acres on which 100% yield losses typically occurred at an estimated frequency of 2 years out of 10. An additional 6,523 acres of upstream farm land experienced moderate yield reductions of up to 10% below the area average due to a combination of the foregoing factors.

11.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved water management under the project. Construction of the ditch and control structures has substantially reduced flooding from spring and summer water run-off both adjacent to the lake and in the up-stream farming area.

Primary agricultural benefits accrued directly to local area farmers and the agricultural sector. Agricultural benefits were reflected in production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity.

The Area Authority reported that the project helped increase feed production in support of a major expansion of hog production in the area. The magnitude of expanded hog production linked to the project was not estimated in this study due to the difficulty of quantifying the proportion of incremental hog production attributable to incremental feed production generated by the water control project.

The Area Authority reported that there have been improvements of water quality in Hatke Lake and increases in waterfowl and hunting due to stabilization of lake water levels. The value of improving water quality and stabilizing waterfowl and wildlife habitat adjacent to the lake to support increased populations could not be estimated due to insufficient data on the actual incremental magnitude of waterfowl and wildlife numbers and hunting activities in the area.

Overall, the Area Authority advised that the bio-physical improvements and economic impacts have been so significant as a result of better local water management stemming from the project that they could never imagine going back to the situation prior to implementation of the project.

Estimates of the value of agricultural benefits are calculated for the Hatke Lake project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the project on the local and provincial economy are presented in the subsequent section on the results of the analysis.

11.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

11.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 11.1. Survey work was completed and construction began in 1978. Construction continued over the next three years and was completed in 1981.

Table 11.1: Time Period and Amount of Construction Expenditures, Hatke Lake Project

Year	Activity	Expenditures
1978	Survey Ends/Construction	$81,559
1979	" (Benefit flows begin)	$94,819
1980	"	$21,875
1981	Construction Complete	$6,266
Total - current dollars		$204,519
Total - constant year 2000 dollars		$372,348

Funds were invested in attainment of right-of-way and earthmoving to create a drainage channel. Culverts, control gates, drop structures and drop inlets were installed to control water flow into and along the drainage ditch. An estimated 85% of the expenditures were invested within 50 miles of the project, with the balance being spent elsewhere in Saskatchewan. Ducks Unlimited participated in cost sharing of the project, along with the local municipality, the Area Authority and the provincial government. The contribution of Ducks Unlimited relates to the lake stabilization and habitat management aspects of the water control project.

Total construction costs in current dollars were $204,519. The value of the capital investment in constant year 2000 dollars is estimated to be $372,348. The salvage value of project works is estimated to be $43,501 in constant year 2000 dollars.

11.2.2 Operation and Maintenance Costs

The first year of project operation was 1979. The expected life of project operation from the date of commencement of the flow of benefits is 50 years (i.e., 1979 to 2028). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2029 are $181,874 in current dollars and $222,232 constant year 2000 dollars. Ducks Unlimited incurred additional expenses, not included in the analysis, for operation and maintenance of their waterfowl habitat management project constructed as part of the multi-purpose lake stabilization measures.

11.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from reclamation of flooded land adjacent to the lake and sloughs on up-stream farm land, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and somewhat synergistic. Identifying each of these changes and adding them together could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that crop yield equivalents were below area average yields by up to 10% for land moderately affected by poor drainage. Based on actual farming experience during the 1979 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land of 830 acres, the yield improvement is 100% for the 2 years in 10 of complete crop loss and 10% for the remaining 8 years in 10; and, for the moderately affected land area of 6,523 acres, the yield improvement is 10%.

It was assumed that the yield equivalent improvements required a 25% increase in fertilizer costs for moderately affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production data obtained from Saskatchewan Agriculture and Food (2002), which internalized agricultural technology changes. During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola with adjustments in cost to reflect changing technology towards increased conservation tillage. Incremental livestock benefits were identified for the project but not calculated due to the difficulty of attribution.

11.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

Measurement of benefits of improved waterfowl and wildlife habitat as well as increased hunting associated with the project were not undertaken due to lack of data.

11.3 Results of Analysis

The results of the analysis for the Hatke Lake conservation and development project are summarized in Table 11.2.

11.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $10.78 and $9.37 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $806,880 based on a 5% discount rate and $218,970 based on a 10% discount rate for the base year crop prices. Net present values are slightly lower for 10-year average crop prices.

The benefit-cost ratios are 2.67 and 1.55 respectively for 5% and 10% discount rates for base year prices and slightly lower for 10-year average crop prices. The internal rate of return is estimated to be 15.8% based on base year crop prices and 13.64% for 10-year average crop prices.

Table 11.2: Summary of Indicators, Hatke Lake Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$372.35	
Capital cost/acre	$ constant (2000)	$27.81	
Area affected	Acres	10544	
New Area Created (Maturity)	Acres	166	
Weighted benefits/acre	$	$10.78	$9.37
Net Present Value -- 5%	$1,000	$806.88	$620.28
Net Present Value -- 10%	$1,000	$218.97	$133.73
Benefit-Cost Ratio	5%	2.67	2.28
	10%	1.55	1.34
Internal Rate of Returns	%	15.80%	13.64%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$2,508.18	$2,495.41
Gross Domestic Product	1,000 $	$3,543.92	$3,489.80
Income	1,000 $	$2,968.40	$2,918.73
Imports	1,000 $	$411.07	$409.70
Employment	FTE Jobs	70	69
Present value at 10%			
Sales	1,000 $	$1,555.47	$1,546.33
Gross Domestic Product	1,000 $	$1,948.04	$1,910.10
Income	1,000 $	$1,609.24	$1,574.41
Imports	1,000 $	$259.54	$258.58
Employment	FTE Jobs	70	69
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$7.40	$7.36
Gross Domestic Product		$10.45	$10.29
Income		$8.76	$8.61

11.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $3.5 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $3.0 million while the increase in full-time equivalent employment is 70 person-years. All results are slightly lower for 10-year average crop prices and a 10% discount rate.

Economic development multipliers for the project per dollar of investment are.$7.40 for sales, $10.45 for the provincial gross domestic project and $8.76 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, personal income, for example, increases in total over the life of the project by over 8.0 times.

12.0 LEROY WEST PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Leroy West project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

12.1 Description of Project

The Leroy West project is operated by the Leroy West Conservation and Development Area Authority. The project is located in Township 34, Range 20, west of 2nd Meridian and Townships 34 and 35, Ranges 19 and 20, west of 2nd Meridian in the Rural Municipality of Leroy No. 339. It is classified as a drainage and flood control project.

The purpose of the project was to alleviate flooding problems on farmlands in the area. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were originally initiated with a petition from area farmers in 1951. Initial survey work was commenced at that time but then delayed until the early 1970's.

The major activities undertaken through the project were construction of approximately 10 miles of drainage ditches, installation of one crossing and construction of two drop structures. The town water line was deepened and insulated to accommodate the ditch. The assessed area for purposes of project planning was 11,232 acres while assessed area for project operation and maintenance is 9,618 acres. The area assessed for project construction purposes was 7,333 acres, the area that land surveys indicated would benefit from reduced flooding and improved drainage resulting from the project.

12.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of frequent annual flooding of about 25% of the farmland in the area. There was a build-up of water from spring run off and excessive summer rains in low areas. With no outlet for the excess water, slough weed growth and salinity were among problems reported by farmers. Problems experienced by farmers in the area were as follows:

- Loss of productive farmland from flooding and salinity build-up;
- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness

- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Farm land in the area was typically subject to 100% crop losses due to flooding at an estimated frequency of 8 years out of 10. Total area affected in this manner was 2,800 acres. An additional 8,400 acres of farm land experienced moderate yield reductions of up to 10% below the area average due to a combination of the foregoing factors. The CPR rail line in the area was typically flooded or washed out annually.

12.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved water management under the project. Construction of the drainage ditch and control structures had substantially reduced, by an estimated 98%, flooding of farm land in the area from spring and summer water run-off.

Primary agricultural benefits accrue directly to local area farmers and to the agricultural sector. Agricultural benefits are reflected in production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity on the affected lands.

The Area Authority reported that the project helped increase feed production in support of major expansion of hog production in the area. The magnitude of expanded hog production linked to the project was not estimated in this study due to the difficulty of quantifying the proportion of incremental hog production attributable to incremental feed production generated by the water control project.

The Area Authority reported that there have been improvements of water quality in the Lanigan Creek and nearby Long Lake, and increases in waterfowl and hunting due to better management of drainage water flows into the downstream watershed from the project. The value of improving water quality and enhancing waterfowl and wildlife habitat downstream could not be estimated due to insufficient data on the actual incremental magnitude of waterfowl and wildlife numbers and hunting activities in the area. The Area Authority also

indicated that nearby community pastures have also benefitted from improved water management in the area and the CPR railway serving the area no longer experiences roadbed and track flooding/washouts.

Overall, the Area Authority advised that the bio-physical improvements and economic impacts have been so significant, as a result of better local water management stemming from the project, that they could never imagine going back to the poor drainage and flooding that existed before implementation of the project.

Estimates of the value of agricultural and flood damage reduction benefits are calculated for the Leroy West project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the project on the local and provincial economy are presented in the subsequent section on the results of the analysis.

12.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

12.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 12.1. Following completion of surveys, construction began in 1974. Construction continued over the next eight years, finishing in 1983.

Funds were invested in attainment of right-of-way and earthmoving to create the drainage channel. Culverts, a crossing and drop structures were installed to control water flow into and along the drainage ditch. Changes were made to the waterline serving the town of Leroy to accommodate the ditch and to prevent freezing. Total construction costs in current dollars were $163,474. The value of the capital investment in constant year 2000 dollars is estimated to be $364,273. The salvage value of project works is estimated to be $72,810 in constant year 2000 dollars.

12.2.2 Operation and Maintenance Costs

The first year of project operation was 1976. The expected life of project operation after completion of construction is 45 years (i.e., 1984 to 2029). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and

then projected to 2029 are $192,214 in current dollars and $247,020 constant year 2000 dollars.

Table 12.1: Time Period and Amount of Construction Expenditures, Leroy West Project

Year	Activity	Expenditures
1974	Survey Ends/Construction	$23,640
1975	Construction contd.	$56,405
1976	Construction Contd. (Benefit flows begin)	$49,688
1977	Construction contd.	$7,955
1978	Construction contd.	$118
1979	Construction contd.	$707
1980	Construction contd.	$6,058
1981	Construction contd.	$18,755
1982		$0
1983	Construction Complete	$148
Total - current dollars		$163,474
Total - constant year 2000 dollars		$364,273

12.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from reclamation of flooded farm land in the area, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult. To avoid double-counting of benefits, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that crop yield equivalents were below area average yields by up to 10% for land moderately affected by poor drainage. Based on actual farming experience during the 1976 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land of 2,800 acres, the yield improvement is 100% for the 8 years in 10 of complete crop loss and 10% for the remaining 2 years in 10; and, for the moderately affected land area of 8,400 acres, the yield improvement

was 10%.

It was assumed that the yield equivalent improvements required a 25% increase in fertilizer costs for moderately affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization were assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production data obtained from the Saskatchewan Department of Agriculture and Food (2002). During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola with adjustments in cost to reflect changing technology towards increased conservation tillage. Incremental livestock benefits were identified for the project but not calculated due to the difficulty of attribution.

12.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

Measurement of reported benefits of improved waterfowl and wildlife habitat as well as increased hunting were not undertaken due to lack of data.

Flood damage reduction benefits associated with elimination of flooding and washouts of the CPR rail line running through the area were calculated. Estimates of flood damage reduction are based on data from the Area Authority that one railway flood event or washout typically occurred on an annual basis prior to construction of the project.

The cost of flood damage was estimated at $6,000 per flood event based on the cost of labor, materials and equipment needed to repair the flooded railroad bed and track after recession of flood waters. The cost of repairs was based on use of a crew of six persons working for two days at a rate of $500 per person, including the cost of materials and equipment. No estimate was calculated for the loss of business to the railway as it was assumed that business would only be delayed for several weeks until repairs were completed to the road bed and track.

12.3 Results of Analysis

The results of the analysis for the Leroy West conservation and development project are summarized in Table 12.2.

12.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $16.86 and $14.87 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $1,204,850 based on a 5% discount rate and $261,830 based on a 10% discount rate for the base year crop prices. Net present values are significantly lower for 10-year average crop prices.

The benefit-cost ratios are 1.80 and 1.28 respectively for 5% and 10% discount rates for base year prices and slightly lower for 10-year average crop prices. The internal rate of return is estimated to be 14.4% based on base year crop prices and 12.18% for 10-year average crop prices.

12.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $11.8 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $8.6 million while the increase in full-time equivalent employment is 483 person-years. All results are slightly lower for 10-year average crop prices and substantially lower for a 10% discount rate.

Economic development multipliers for the project per dollar of investment are $48.91 for sales, $37.76 for the provincial gross domestic project and $27.54 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, sales of all goods and services in the economy, for example, increase in total over the life of the project by 48.9 times.

Table 12.2: Summary of Indicators, Leroy West Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$364.27	
Capital cost/acre	$ constant (2000)	$15.36	
Area affected	Acres	0	
New Area Created (Maturity)	Acres	2240	
Weighted benefits/acre	$	$16.86	$14.87
Net Present Value -- 5%	$1,000	$1,204.85	$896.51
Net Present Value -- 10%	$1,000	$261.83	$127.14
Benefit-Cost Ratio	5%	1.8	1.6
	10%	1.28	1.14
Internal Rate of Returns	%	14.40%	12.18%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$15,318.55	$15,303.63
Gross Domestic Product	1,000 $	$11,827.22	$11,767.93
Income	1,000 $	$8,625.74	$8,571.32
Imports	1,000 $	$2,833.34	$2,831.84
Employment	FTE Jobs	483	482
Present value at 10%			
Sales	1,000 $	$6,695.36	$6,690.31
Gross Domestic Product	1,000 $	$5,051.84	$5,031.76
Income	1,000 $	$3,636.04	$3,617.61
Imports	1,000 $	$1,313.08	$1,312.57
Employment	FTE Jobs	483	482
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$48.91	$48.86
Gross Domestic Product		$37.76	$37.57
Income		$27.54	$27.37

13.0 ST. GREGOR SOUTH PROJECT

This section contains analysis of the economic efficiency and impacts of the St. Gregor South project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this section.

13.1 Description of Project

The St. Gregor South project is operated by the St. Gregor South Conservation and Development Area Authority. The project is located in Townships 34 to 37, Range 20 and 21, west of the 2nd Meridian in Rural Municipality of Leroy No. 339 and Rural Municipality No. 369. The project is classified as a drainage and flood control project. The purpose of the project was to alleviate flooding problems on farmlands in the area. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were originally initiated with a petition from area farmers prior to 1974.

The major activities undertaken through the project were construction of approximately 26 miles of drainage ditches, installation of 20 rockford crossings and construction of 21 flax drop structures. The assessed area for purposes of project planning was 65,209 acres while assessed area for project operation and maintenance is 56,516 acres. Area assessed for project construction purposes was 5,000 acres, the area that land surveys indicated would benefit in the immediate short run from reduced flooding and improved drainage resulting from the project.

13.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of periodic annual flooding of farmland in the area. There was a build-up of water from spring run off and excessive summer rains in low areas. With no outlet for the excess water slough, weed growth and salinity were among problems reported by farmers. Problems experienced by farmers in the area were as follows:

- Loss of productive farmland from flooding and salinity build-up;
- Production of crops with lower market value (e.g., feed barley, early maturing canola, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;

- Increased weed populations in and adjacent to sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Prior to implementation of the project farmers were beginning to undertake private, unregulated drainage. Formation of the Area Authority and design of the project gave the whole project credibility and a legal basis for funding and operation.

Farm land in the area typically was subject to 100% crop losses due to flooding at an estimated frequency of 2 years out of 10. This area was estimated at a total of 7,064 acres. An additional 49,452 acres of farm land experienced moderate yield reductions of up to 10% below the area average due to a combination of the foregoing factors. There were up to five washouts of municipal roads annually and/or they were always soft causing significant delays in grain hauling in the spring or after excessive summer rains.

13.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved water management under the project. Construction of the drainage ditch and control structures have significantly reduced flooding of farm land in the area from spring and summer water run-off.

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Primary agricultural benefits accrue directly to local area farmers and to the agricultural sector. Agricultural benefits were reflected in production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity on the affected lands. The Area Authority advised that monitoring sites and studies in the area confirm the positive impact of the project on reducing salinity levels.

The Area Authority reported that the project helped increase feed production in support of major livestock production facilities in the area. The magnitude of expanded livestock production linked to the project was not estimated in this study due to the difficulty of quantifying the proportion of incremental livestock production attributable to incremental feed production generated by the water control project.

The Area Authority reported that there have been increases in waterfowl numbers and hunting due to better management of drainage water flows into the downstream watershed from the

project. The value of enhancing waterfowl and wildlife habitat downstream could not be estimated due to insufficient data on the actual incremental magnitude of waterfowl and wildlife numbers and hunting activities in the area either with or without the project. The Area Authority also indicated that municipal road washouts were eliminated through improved water management control and management made possible by the project.

Overall, the Area Authority advised that the bio-physical improvements and economic impacts have been very positive from a social and community perspective. There is reduced stress and conflicts among farmers during periods of excessive water run-off. The rural municipality has fewer problems maintaining roads and farmers are able to travel on the roads sooner than would be the case without the project.

Estimates of the value of agricultural and flood damage reduction benefits are calculated for the St. Gregor South project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the project on the local and provincial economy are presented in the subsequent section on the results of the analysis.

13.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

13.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 13.1. Survey and design work began in 1974 and ended in 1981 at which point project construction commenced. Construction continued over the next six years ending in 1987. However, some benefits started to flow from the project since 1982.

Funds were invested in attainment of right-of-way and earthmoving to create the drainage channel. Culverts, crossings and drop structures were installed to control water flow into and along the drainage ditch. Total construction costs in current dollars were $814,515. The value of the capital investment in constant year 2000 dollars is estimated to be $1,219,884. The salvage value of project works is estimated to be $243,977 in constant year 2000 dollars.

13.2.2 Operation and Maintenance Costs

The first year of project operation was 1982. The expected life of project operation after completion of construction is 40 years (i.e., 1987 to 2026). Total project operating and

maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2027 are $560,704 in current dollars and $616,786 in constant year 2000 dollars.

Table 13.1: Time Period and Amount of Construction Expenditures, St. Gregor S. Project

Year	Activity	Expenditures
1974	Survey/Design Begins	
1975-80		
1981	Design Ends/Construction	$203,290
1982	Construction Contd. (Benefit flows begin)	$275,207
1983	Construction Contd.	$287,154
1984	Construction Contd.	$35,253
1985	Construction Contd.	$5,570
1986	Construction Contd.	$5,131
1987	Construction Complete	$2,910
Total - current dollars		$814,515
Total - constant year 2000 dollars		$1,219,884

13.2.3 Agricultural Benefits

The agricultural benefits resulting from the project flow from reclamation of flooded farm land in the area, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that crop yield equivalents were below area average yields by up to 10% for land moderately affected by poor drainage. Based on actual farming experience during the 1982 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land of 7,064 acres, the yield improvement was estimated to be 100% for the 2 years in 10 of complete crop loss and 10%

for the remaining 8 years in 10; and, for the moderately affected land area of 49,452 acres, the yield improvement was 10%.

It was assumed that the yield equivalent improvements required a 25% increase in fertilizer costs for moderately affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization were assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production formula developed in this study to internalize agricultural technology changes. During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, the technology change formula and fixed crop rotations were used for analysis of this project. The crop rotation consisted of 50% wheat, 25% field peas and 25% canola with adjustments in cost to reflect changing technology towards increased conservation tillage. Incremental livestock benefits were identified for the project but not calculated due to the difficulty of attribution.

13.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

Flood damage reduction benefits associated with elimination of municipal road washouts were calculated. Estimates of flood damage reduction were based on data from the Area Authority that five municipal road washouts typically occurred on an annual basis prior to construction of the project.

The cost of flood damage was estimated at $2,000 per flood event based on the cost of labor, materials and equipment needed to repair the washed out road after recession of flood waters. The cost of repairs for each flood event was based on use of a crew of two persons working for two days at a rate of $500 per person, including the cost of materials and equipment. No estimate was calculated for loss of business by farmers as it was assumed that business would only be delayed for several weeks until repairs were completed on the road or farmers would use alternate roads.

13.3 Results of Analysis

The results of the analysis for the St. Gregor South conservation and development project are summarized in Table 13.2.

13.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $10.13 and $9.40 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $5.1 million based on a 5% discount rate and $1.7 million based on a 10% discount rate for the base year crop prices. Net present values are slightly lower for 10-year average crop prices.

The benefit-cost ratios are 3.9 and 2.24 respectively for 5% and 10% discount rates for base year prices and slightly lower for 10-year average crop prices. The internal rate of return is estimated to be 20.18% based on base year crop prices and 19.70% for 10-year average crop prices.

13.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $19.0 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $16.1 million while the increase in full-time equivalent employment is 376 person-years. All results are slightly lower for 10-year average crop prices and substantially lower at a 10% discount rate.

Economic development multipliers for the project per dollar of investment are $12.16 for sales, $17.73 for the provincial gross domestic project and $14.99 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, provincial gross domestic product, for example, increases in total over the life of the project by 17.73 times.

Table 13.2: Summary of Indicators, St. Gregor South Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$1,219.88	
Capital cost/acre	$ constant (2000)	$16.01	
Area affected	Acres	0	
New Area Created (Maturity)	Acres	1412.8	
Weighted benefits/acre	$	$10.13	$9.40
Net Present Value -- 5%	$1,000	$5,130.47	$4,808.53
Net Present Value -- 10%	$1,000	$1,693.39	$1,564.91
Benefit-Cost Ratio	5%	3.9	3.72
	10%	2.24	2.15
Internal Rate of Returns	%	20.18%	19.70%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$13,058.87	$11,755.06
Gross Domestic Product	1,000 $	$19,031.49	$16,219.45
Income	1,000 $	$16,091.59	$13,529.02
Imports	1,000 $	$2,035.33	$1,960.87
Employment	FTE Jobs	376	252
Present value at 10%			
Sales	1,000 $	$7,126.29	$6,666.46
Gross Domestic Product	1,000 $	$9,987.00	$8,942.04
Income	1,000 $	$8,414.21	$7,461.21
Imports	1,000 $	$1,135.42	$1,107.89
Employment	FTE Jobs	376	252
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$12.16	$10.95
Gross Domestic Product		$17.73	$15.11
Income		$14.99	$14.99

14.0 TORQUAY WEST PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Torquay West project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

14.1 Description of Project

The Torquay West project is operated by the Torquay West Conservation and Development Area Authority. The project is located in Township 2, Range 12, west of the 2nd Meridian in the Rural Municipality of Cambria No. 6. The project is classified as a drainage and flood control project. The purpose of the project was to reclaim for cultivation, slough land subject to regular flooding problems from spring run-off and summer rains. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated with a petition by area farmers in 1983. The soil was tested and found to be suitable for annual cropping.

The major activities undertaken through the project were construction of a drainage channel and control structures. The assessed area for purposes of project planning was 727 acres while area assessed for construction, operation and maintenance consists of 651 acres, the approximate area that land surveys indicated would benefit from improved drainage resulting from the project.

14.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of regular annual flooding of cultivated slough land. Excessive water would flood the land almost every year and drown out planted crops. The problems reported by farmers due to excessive water run off were as follows:

- Loss of productive farmland from flooding and salinity;
- Production of crops with lower market value (e.g., feed barley, oats, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to the sloughs; and,
- Reduced machinery operation efficiency due to excessive turning around low areas.

Farm land in the area typically subject to 100% crop losses due to flooding, at an estimated frequency of 9 years out of 10, totaled 665 acres. An additional 651 acres of farm land experienced moderate yield reductions of up to 10% below the area average due to a combination of the foregoing factors. Flax would typically be produced on the land in years when excess water did not flood out the crop.

14.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved flood control and water management under the project. Construction of the drainage ditch and control structures have significantly reduced flooding of farm land in the area from spring and summer water run-off.

Primary agricultural benefits accrued directly to local area farmers and to the agricultural sector. Agricultural benefits were reflected in increased production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity on the affected lands.

The Area Authority reported that there have been decreases in waterfowl numbers due to reduction in slough area, however there are other water and habitat sites in the area. Feed is provided by farmers for waterfowl. No negative downstream impacts on Long Creek were identified as the control gates for the run-off into the creek are not opened until other run-off is complete and authority is granted by SaskWater.

Overall, the Area Authority advised that the bio-physical improvements and economic impacts have been very positive. Landowners are reported by the Area Authority to be "100% satisfied with our drainage ditch."

Estimates of the value of agricultural benefits are calculated for the Torquay West project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the project on the local and provincial economy are presented in the subsequent section on the results of the analysis.

14.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

14.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 14.1. Survey and design work was completed in 1983 and construction completed in 1984.

Funds were invested in attainment of right-of-way and earthmoving to create the drainage channel. Culverts, crossings and drop structures were installed to control water flow into and along the drainage ditch. Total construction costs in current dollars were $279,500. The value of the capital investment in constant year 2000 dollars is estimated to be $395,832. The salvage value of project works is estimated to be $79,166 in constant year 2000 dollars.

Table 14.1: Time Period & Amount of Construction Expenditures, Torquay West Project

Year	Activity	Expenditures
1983	Survey and Design	
1984	Construction Complete	$279,500
1985	(Benefit flows begin)	
Total - current dollars		$279,500
Total - constant year 2000 dollars		$395,832

14.2.2 Operation and Maintenance Costs

The first year of project operation was 1985. The expected life of project operation after completion of construction is 30 years (i.e., 1985 to 2014). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2015 are $56,668 in current dollars and $63,200 constant year 2000 dollars.

14.2.3 Agricultural Benefits

The agricultural benefits resulting from the project stem from reclamation of flooded farm land in the area, improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

It was estimated that crop yield equivalents were below area average yields by up to 10% for land moderately affected by poor drainage. Based on actual farming experience during the 1985 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to average yield levels for all crops produced in the total project area. For reclaimed land of 665 acres, the yield improvement is 100% for the 9 years in 10 of complete crop loss and 10% for the remaining 1 year in 10; and, for the moderately affected land area of 651 acres, the yield improvement is 10%.

It was assumed that the yield equivalent improvements required a 25% increase in fertilizer costs for moderately affected land. Use of additional fertilizer was assumed to be necessary in order to bring reduced fertilizer usage on pre-project land prone to flooding up to the area norm. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production data obtained from Saskatchewan Agriculture and Food (2002). Since the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, the technology change was assumed to be linear up until the year 2000, and fixed crop rotations were used for analysis of this project. The crop rotation consisted of 25% wheat, 25% flax, 25% lentils and 25% canola with adjustments in cost to reflect changing technology towards increased conservation tillage. No incremental livestock benefits were identified for the project.

14.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

Measurement of dis-benefits of reduced waterfowl numbers and wildlife habitat was not undertaken due to lack of data.

14.3 Results of Analysis

The results of the analysis for the Torquay conservation and development project are summarized in Table 14.2.

14.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $19.35 and $25.99 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is -$1,410 based on a 5% discount rate and -$146,400 based on a 10% discount rate for the base year crop prices. Net present values are slightly higher for 10-year average crop prices.

The benefit-cost ratios are 1.0 and 0.61 respectively for 5% and 10% discount rates for base year prices and slightly higher for 10-year average crop prices. The internal rate of return is estimated to be 4.97% based on base year crop prices and 7.37% for 10-year average crop prices. Thus, this project does not qualify on the economic desirability criterion, since the benefits are equally outweighed by cost of the resources used in its development.

14.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $2.2 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $1.5 million while the increase in full-time equivalent employment is 40 person-years. All results are slightly lower for 10-year average crop prices and a 10% discount rate, except employment which remains constant.

Economic development multipliers for the project per dollar of investment are.$6.69 for sales, $4.18 for the provincial gross domestic project and $2.72 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, sales of all goods and services in the economy, for example, increase in total over the life of the project by 6.69 times.

Table 14.2: Summary of Indicators, Torquay West Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$395.83	
Capital cost/acre	$ constant (2000)	$300.78	
Area affected	Acres	1316	
New Area Created (Maturity)	Acres	665	
Weighted benefits/acre	$	$19.35	$25.99
Net Present Value -- 5%	$1,000	-$1.41	$116.56
Net Present Value -- 10%	$1,000	-$146.40	-$80.10
Benefit-Cost Ratio	5%	1	1.3
	10%	0.61	0.79
Internal Rate of Returns	%	4.97%	7.37%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$3,748.83	$3,739.25
Gross Domestic Product	1,000 $	$2,249.62	$2,211.51
Income	1,000 $	$1,453.42	$1,418.44
Imports	1,000 $	$685.79	$684.83
Employment	FTE Jobs	40	40
Present value at 10%			
Sales	1,000 $	$2,417.50	$2,411.71
Gross Domestic Product	1,000 $	$1,509.16	$1,486.16
Income	1,000 $	$981.04	$959.94
Imports	1,000 $	$462.34	$462.34
Employment	FTE Jobs	40	40
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$6.69	$6.68
Gross Domestic Product		$4.18	$4.11
Income		$2.72	$2.66

15.0 WIWA CREEK PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Wiwa Creek project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

15.1 Description of Project

The Wiwa Creek project is operated by the Wiwa Creek Conservation and Development Area Authority No. 8. The project is located in the Rural Municipality of Gravelbourg No. 104 and the Rural Municipality of Shamrock No. 134. The original purpose of the project was to reduce flooding problems on low lying farmlands in the Wiwa Creek area. Subsequently, a backflood irrigation feature was added to the project as part of a broader plan resulting in the project being classified as a partial multi-purpose project with drainage and spring backflood irrigation features. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated by local farmers in the early 1950's.

The major activities undertaken through the project were initial construction of 4 miles of earthen ditch in an old creek bed, followed by construction of 17 miles of new ditch. Five main backflood structures were erected and many secondary dykes and control structures were built. The assessed area for purposes of project planning and operation consists of 2,652 acres, the area that land surveys indicated would benefit from improved drainage and irrigation resulting from the project.

15.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of regular annual flooding in the village and onto adjacent lands as a result of excessive spring water run off from farmlands in the up-stream drainage area. The problems reported by farmers due to slow water run off in the up-stream drainage area were as follows:

- Loss of productive farmland from flooding and salinity;
- Production of crops with lower market value (e.g., feed barley, oats, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to sloughs; and,

- Reduced machinery operation efficiency due to excessive turning around low areas.

The flooding problem was created, in part, by construction of drainage channels on up-stream farmlands over the years prior to implementation of the project. Flood water came at regular frequencies from both Wiwa Creek and upstream flowing well systems. The Area Authority considered that no other adjacent upland farm land area would benefit from a future drainage project, since most of the upland normally drained into the creek.

Farm land in the area typically subject to 100% crop losses due to flooding, at an estimated frequency of 1 year out of 4, totaled 2652 acres. Land use prior to the project would typically consist of a 50:50 wheat-summerfallow rotation when excess water did not flood out the crop. No spring backflood irrigation was possible prior to the project because of the absence of necessary water control structures.

15.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved flood control and water management under the project. Construction of the drainage ditch, secondary dykes and control structures have eliminated uncontrolled flooding of farm land in the project area.

Primary agricultural benefits accrued directly to local area farmers and to the agricultural sector. Agricultural benefits were reflected in increased production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity on the affected lands.

At the same time, the subject lands benefit from construction of 5 spring backflood irrigation cells. Spring run-off water is left on the land to soak into the soil for a short period of time and then released through control structures to the drainage ditch to ensure timely seeding operations. The backflood irrigation feature has the effect of increasing crop yields on the cultivated heavy clay lowland to levels above area average yields.

Estimates of the value of agricultural benefits are calculated for the Wiwa Creek project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the project on the local and provincial

economy are presented in the subsequent section on the results of the analysis.

15.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

15.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 15.1. Survey work was completed and construction began in 1968. Construction continued in various stages over the next 24 years until completion in 1992.

Table 15.1: Time Period and Amount of Construction Expenditures, Wiwa Creek Project

Year	Activity	Expenditures
1968	Survey Ends/Construction	$24,035
1969	Construction Contd. (Benefit flows begin)	$3,044
1971	Construction Contd.	$3,180
1973	Construction Contd.	$179
1975	Construction Contd.	$4,400
1982	Construction Contd.	$3,200
1983	Construction Contd.	$919
1984	Construction Contd.	$6,547
1985	Construction Contd.	$455
1986	Construction Contd.	$655
1989	Construction Contd.	$5,474
1990	Construction Contd.	$77,196
1992	Construction Complete	$5,443
Total - current dollars		$134,727
Total - constant year 2000 dollars		$269,660

Funds were initially invested in construction of 4 miles of main ditch in the Wiwa Creek bed as part of a PFRA and provincial government project in 1956. The project was then put on hold until a master plan was developed which provided for construction of an additional 17 miles of ditch and 5 main backflood irrigation structures, erection of numerous secondary dykes and control structures. The resulting project has provided two main north-south roads which are used as dykes as well as creek crossings and overpasses which has enhanced commercial traffic flow in the area.

Total construction costs in current dollars were $134,727. The value of the capital investment in constant year 2000 dollars is estimated to be $269,660. The salvage value of project works is estimated to be $88,988 in constant year 2000 dollars.

15.2.2 Operation and Maintenance Costs

The first year of project operation was 1969. The expected life of project operation from the beginning of the flow of benefits is 50 years (i.e., 1969 to 2018). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2019 are $308,881 in current dollars and $386,732 in constant year 2000 dollars.

15.2.3 Agricultural Benefits

The agricultural benefits resulting from the project stem from reclamation of flooded farm land in the creek bed and improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

Based on actual farming experience during the 1969 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to at least average yield levels for all crops produced in the total project area. For reclaimed land of 2,652 acres, the yield improvement is 100% for the 1 year in 4 of complete crop loss and 10% for the remaining 3 years in 4.

The yield increase due to backflood irrigation is estimated at 30% above area average yields for all crops produced on the 2,652 acres drained by the project. It is assumed that this yield increase is achieved with a 20% increase in fertilizer application above normal usage for the area, with the presence of abundant soil moisture. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases

over and above those associated with technology change.

Crop production costs were based on the normalized cost of production formula developed in this study to internalize agricultural technology changes. During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, fixed crop rotations under alternative technology of production were used for analysis of this project. The crop rotation for backflood irrigation consisted of 10% tame hay with the balance as 50% wheat, 25% lentils and 25% canola with no summerfallow, and adjustments in cost to reflect changing technology towards increased conservation tillage. No incremental livestock benefits were identified for the project.

15.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis.

15.3 Results of Analysis

The results of the analysis for the Wiwa Creek conservation and development project are summarized in Table 15.2.

15.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $36.52 and $44.81 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $928,870 based on a 5% discount rate and $402,850 based on a 10% discount rate for the base year crop prices. Net present values are slightly lower for 10-year average crop prices.

The benefit-cost ratios are 3.33 and 2.52 respectively for 5% and 10% discount rates for base year prices and very similar for 10-year average crop prices. The internal rate of return is estimated to be 35.8% based on base year crop prices and 30.02% for 10-year average crop prices.

Table 15.2: Summary of Indicators, Wiwa Creek Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$269.66	
Capital cost/acre	$ constant (2000)	$116.90	
Area affected	Acres	2306.8	
New Area Created (Maturity)	Acres	317.8	
Weighted benefits/acre	$	$36.52	$44.81
Net Present Value -- 5%	$1,000	$928.87	$951.38
Net Present Value -- 10%	$1,000	$402.85	$368.58
Benefit-Cost Ratio	5%	3.33	3.38
	10%	2.52	2.39
Internal Rate of Returns	%	35.80%	30.02%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$2,149.51	$2,014.32
Gross Domestic Product	1,000 $	$1,909.85	$1,479.70
Income	1,000 $	$1,467.35	$1,072.00
Imports	1,000 $	$377.08	$370.18
Employment	FTE Jobs	60	56
Present value at 10%			
Sales	1,000 $	$1,168.02	$1,080.53
Gross Domestic Product	1,000 $	$739.63	$739.63
Income	1,000 $	$529.22	$529.22
Imports	1,000 $	$205.99	$205.99
Employment	FTE Jobs	60	56
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$12.85	$12.04
Gross Domestic Product		$11.42	$8.85
Income		$8.77	$6.41

15.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $1.9 million at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $1.5 million while the increase in full-time equivalent employment is 60 person-years. All results are slightly lower for 10-year average crop prices and a 10% discount rate, except employment which remains constant.

Economic development multipliers for the project per dollar of investment are.$12.85 for sales, $11.42 for the provincial gross domestic project and $8.77 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, sales of all goods and services in the economy, for example, increase in total over the life of the project by 12.9 times.

16.0 GREEN LAKE PROJECT

This chapter contains analysis of the economic efficiency and impacts of the Green Lake project. A description of the basic characteristics of the project, assumptions employed for purposes of the evaluation and results of the analysis are outlined in this chapter.

16.1 Description of Project

The Green Lake project is operated by the Green Lake Conservation and Development Area Authority. The project is located in the Rural Municipality of Mountain View No. 318. The project is classified as a drainage and flood control project. The purpose of the project was to drain the lowland known as "Green Lake" so it could be brought under cultivation without threat of frequent flooding. Discussions with local and provincial authorities on potential alternatives for resolving the flooding problems were initiated by area farmers in 1966 with a first meeting of the Area Authority. The provincial government was approached for funding assistance in 1968.

The major activities undertaken through the project was construction of a main ditch, short laterals to drain spring and summer run-off water from the lake and a control structure. Subsequent earthwork was undertaken to control slope failure and upheaval in the ditch. The assessed area for purposes of project planning, construction and operation consists of 682 acres, the only land area considered by the Area Authority to benefit from improved drainage resulting from the project.

16.1.1 Conditions Prior to the Project

The Area Authority reported that the situation prior to the project consisted of frequent annual flooding of the lake as a result of spring and water run off water from adjacent farmlands. The problems reported by farmers due were as follows:

- Loss of productive farmland due to flooding;
- Production of crops with lower market value (e.g., feed barley, oats, etc.) due to delayed seeding;
- Reduced crop yields due to poor seeding timeliness;
- Reduced crop quality due to increased risk of frost;
- Increased weed populations in and adjacent to the lake; and,
- Reduced machinery operation efficiency due to excessive turning around the lake..

Farm land in the lake area typically subject to 100% crop losses due to flooding, at an estimated frequency of 9 years out of 10, totaled 682 acres. Flax would commonly be produced on the land in years when excess water did not flood out the crop. Adjacent uplands would normally drain into the lake and water would be trapped there without access to an outlet. Thus, the Area Authority considered that no other farm land area would benefit from a future drainage project, since the land already drained into the lake.

16.1.2 Changes Arising from the Project

Both agriculture and non-agriculture benefits were identified as arising from the bio-physical changes associated with improved flood control and water management under the project. Construction of the drainage ditch and control structure have substantially reduced flooding of farm land in the lake area.

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Primary agricultural benefits accrued directly to local area farmers and to the agricultural sector. Agricultural benefits were reflected in increased production of more valuable crops due to earlier seeding; more suitable crop rotations; improved crop yields and quality due to more timely seeding; better weed and slough grass control; and, cost savings associated with more efficient machinery operation around low lands.

Cultivated land has been reclaimed for cropping on a regular basis and, overall, crop yields have increased to area average yields because of the longer growing season associated with dryer soil conditions and reduced salinity on the affected lands.

At the same time, the subject lands experienced a backflood irrigation effect in the spring from build up of snow. Snow build-up on the lake area and in the ditch acts as a dam for snow-melt water. Water is left on the land to soak into the soil for a short period of time and then released through the ditch to ensure timely seeding operations. This backflood irrigation practice has the effect of increasing crop yields on the cultivated heavy clay lake bed to levels above area average yields.

The Area Authority reported that there have been decreases in waterfowl numbers due to reduction in slough area because the project was a single purpose agricultural drainage project. Protection or enhancement of waterfowl habitat was not one of the objectives of the project. The project also does not support any recreational activities.

The Area Authority indicated that municipal road washouts were eliminated through improved water management control and management made possible by the project.

Estimates of the value of agricultural and flood reclamation benefits are calculated for the Green Lake project based on assumptions outlined in the next section. The primary non-agricultural benefits associated with indirect impacts of construction and operation of the

project on the local and provincial economy are presented in the subsequent section on the results of the analysis.

16.2 Assumptions and Data Used for Analysis

Assumptions and data are outlined in this section for the capital investment and operating costs of the project, as well as the benefits generated by the project.

16.2.1 Capital Costs

The construction costs of the project and the time period over which the construction expenditures occurred are summarized in Table 16.1. Survey work was completed and construction began in 1969. Construction continued in stages over the next eight years, finishing in 1977. Project benefits began to flow in 1973.

Table 16.1: Time Period and Amount of Construction Expenditures, Green Lake Project

Year	Activity	Expenditures
1969	Survey/Construction	$19,514
1970	Construction Contd.	$8,038
1971	Construction Contd.	$2,036
1972		$0
1973	Construction Contd. (Benefit flows begin)	$2,396
1974		$0
1975		$0
1976	Construction Contd.	$20,718
1977	Construction Complete	$707
Total - current dollars		$53,408
Total - constant year 2000 dollars		$178,800

Funds were invested in construction of a main earthen ditch with several short lateral ditches feeding into the main ditch. The main ditch traverses the lake bed and effectively drains flood water into Eagle Creek. Subsequent construction work corrected slope failure and upheaval occurring in the ditch.

Total construction costs in current dollars were $53,408. The value of the capital investment in constant year 2000 dollars is estimated to be $178,800. The salvage value of project works is estimated to be $53,640 in constant year 2000 dollars.

16.2.2 Operation and Maintenance Costs

The first year of project operation was 1973. The expected life of project operation after commencement of operation is 50 years (i.e., 1973 to 2022). Total project operating and maintenance costs based on experience of the Area Authority to date to the year 2000 and then projected to 2023 are $96,622 in current dollars and $129,681 constant year 2000 dollars.

16.2.3 Agricultural Benefits

The agricultural benefits resulting from the project stem from reclamation of flooded farm land in the lake bed and improvements in cropping patterns, crop yields, crop quality and reduced costs. In interviews with the Area Authority, it was determined that estimation of improvements separately for each of the foregoing benefit factors would be extremely difficult because the effects are interrelated and could result in double-counting of benefits. Because of this interconnectedness, it was agreed, that an estimate of the equivalent crop yield changes with and without the project would be the best way of incorporating the effects of all factors contributing to yield changes.

Based on actual farming experience during the 1973 to 2000 period after benefits began to flow, it was estimated by the Area Authority that all improvements combined have improved the yield equivalent to at least average yield levels for all crops produced in the total project area. For reclaimed land of 682 acres, the yield improvement is 100% for the 9 years in 10 of complete crop loss and 10% for the remaining 1 year in 10.

Because of the backflood irrigation effect of slow snow melt and controlled drainage from the lake, there is an estimated crop yield increases of 20% above area average yields for all crops produced on the 682 acres drained by the project. Because of the presence of adequate soil moisture this yield increase is assumed to be achieved without additional fertilizer applications above normal usage. Cost savings resulting from improved machinery utilization are assumed to offset any other unidentified farm input cost increases over and above those associated with technology change.

Crop production costs were based on the normalized cost of production data provided by Saskatchewan Agriculture and Food (2002). Data were also collected by nature of technology ion production used by producers, thereby internalizing agricultural technology changes. During the time period that benefits flowed from this project, farming technology has changed from conventional tillage to a higher proportion of conservation tillage. During the same time

period there has been increased incorporation of specialty crops, especially pulse crops, into crop rotations.

To eliminate any distortions in benefit estimates due to changes in technology and crop rotations, the technology change formula and fixed crop rotations were used for analysis of this project. The crop rotation consisted of 25% wheat, 25% field peas, 25% canary seed and 25% lentils with adjustments in cost to reflect changing technology towards increased conservation tillage. No incremental livestock benefits were identified for the project.

16.2.4 Non-Agricultural Benefits

Calculation of direct and indirect local employment impacts generated from construction and operation of the project are included in the section on economic impact analysis. Measurement of dis-benefits of reduced waterfowl and wildlife habitat were not undertaken due to lack of data.

Flood damage reduction benefits associated with elimination of municipal road washouts were calculated. Estimates of flood damage reduction are based on data from the Area Authority that two municipal road washouts typically occurred on an annual basis prior to construction of the project. The cost of flood damage was estimated at $2,000 per flood event based on the cost of labor, materials and equipment needed to repair the washed out road after recession of flood waters. The cost of repairs for each flood event was based on use of a crew of two persons working for two days at a rate of $500 per person, including the cost of materials and equipment. No estimate was calculated for loss of business by farmers as it was assumed that business would only be delayed for several weeks until repairs were completed on the road or farmers would use alternate roads.

16.3 Results of Analysis

The results of the analysis for the Green Lake conservation and development project are summarized in Table 16.2.

16.3.1 Benefit-Cost Analysis

The weighted value of incremental net benefits for the project are $44.34 and $41.81 per acre respectively for base year crop prices and 10-year average crop prices. The net present value of the project is $308,860 based on a 5% discount rate and $69,570 based on a 10% discount rate for the base year crop prices. Net present values are slightly higher for 10-year average crop prices.

Table 16.2: Summary of Indicators, Green Lake Project

Indicator	Unit	Base Year Prices, 2002	10-year Average Prices
BENEFIT-COST ANALYSIS			
Total Capital Expenditures	$1,000 constant	$178.80	
Capital cost/acre	$ constant (2000)	$262.17	
Area affected	Acres	682	
New Area Created (Maturity)	Acres	682	
Weighted benefits/acre	$	$44.34	$41.81
Net Present Value -- 5%	$1,000	$308.86	$323.30
Net Present Value -- 10%	$1,000	$69.57	$82.22
Benefit-Cost Ratio	5%	2.49	2.56
	10%	1.43	1.51
Internal Rate of Returns	%	14.29%	15.23%
ECONOMIC IMPACTS			
Present value at 5%			
Sales	1,000 $	$430.32	$730.53
Gross Domestic Product	1,000 $	$798.42	$2,282.90
Income	1,000 $	$684.83	$2,062.23
Imports	1,000 $	$79.57	$95.09
Employment	FTE Jobs	7	18
Present value at 10%			
Sales	1,000 $	$277.93	$417.61
Gross Domestic Product	1,000 $	$454.64	$1,135.77
Income	1,000 $	$377.71	$1,009.30
Imports	1,000 $	$69.12	$69.12
Employment	FTE Jobs	7	18
ECONOMIC DEVELOPMENT MULTIPLIERS PER $ OF INVESTMENT			
Sales		$1.86	$2.79
Gross Domestic Product		$3.04	$7.58
Income		$2.52	$6.74

The benefit-cost ratios are 2.49 and 1.43 respectively for 5% and 10% discount rates for base year prices and slightly higher for 10-year average crop prices. The internal rate of return is estimated to be 14.29% based on base year crop prices and 15.23% for 10-year average crop prices.

16.3.2 Economic Impact Analysis

The total increase in gross domestic product associated with the project during its life is estimated at $798,420 at a 5% discount rate based on base year crop prices. The estimated life-time increase in net income is $684,830 while the increase in full-time equivalent employment is 7 person-years. Results are slightly lower for sales, negative for employment and slightly higher for gross domestic product and income for 10-year average crop prices. Results are lower for a 10% discount rate, except employment which remains constant.

Economic development multipliers for the project per dollar of investment are.$1.86 for sales, $3.04 for the provincial gross domestic project and $2.52 for income, based on base year crop prices. These ratios mean that for every $1 dollar invested in the project, provincial gross domestic product, for example, increases in total over the life of the project by 3.0 times.

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APPENDIX A

SURVEY OF SASKATCHEWAN CONSERVATION AND DEVELOPMENT AREA AUTHORITIES, APRIL 2001

Instructions

1. You can submit as many projects as you have time and pertinent details for.

2. Each project to be selected should qualify on two criteria: One, you should have good details (through records) on the project; and Two, nature of impacts are clear and can be identified. One way to complete the impacts of the project sections is use a "focus group" approach. This focus group may include a number of individuals who are intimately familiar with the project.

3. Please complete one survey form for each project.

4. For each project, please complete Part A and either Parts B, C or D depending on the type of project. For Part E - Multi-purpose projects complete two or more of Parts B, C and D of the survey form that are applicable to the project.

5. If you have any questions, please call:

   Professor Suren Kulshreshtha
   Department of Agricultural Economics,
   University of Saskatchewan, Saskatoon.
   (306) 966-4014.
   Or fax him your question(s) at:
   (306) 978-8331

6. Please return completed survey forms to:

   Coleen Bowman, Secretary-Manager,
   Saskatchewan Conservation & Development Association Inc.
   Box 1613,
   HUMBOLDT, Sask.
   S0K 2A0

PART A
GENERAL INFORMATION

Name of Conservation and Development Area Authority _____

Name of Contact Person (s) _____

Phone Number _____ Fax Number _____ E-mail address _____

Name of Project _____ _____

Project I.D. _____ Location of Project _____

List the RM's in which the project is located _____

Type of Project (Please check one)

_____ Drainage and Flood Control
_____ Backflood Irrigation
_____ Lake Stabilization
_____ Multi-purpose

If multi-purpose, please list various components: _____

PROJECT RATIONALE

A.1 What were economic conditions like in the project area before the project was undertaken (e.g., proportion of area subject to flooding, frequency of flooding, frequency of droughts, low yields, problems encountered, weed problems, reduction in farming efficiency, etc.)?

A.2 What were the main reasons for undertaking the project included in the petition for the project?

A.3 What date was the petition to Sask Water (or Sask Agriculture and Food) to initiate discussions on resolving the problems?

PROJECT CHARACTERISTICS

A.4 What were the major activities undertaken under the project?

A.5 What is the total land area assessed under the project, the range of assessments per acre and the total cost per acre of assessments over the life of the project?

For Project	Area Assessed	Range of Assessments	Total Assessment over
Planning			
Construction			
Operation (Maintenance)			

A.6 Please attach a map of the project, if available. If a small sized map is not available, could you please draw an approximate map and attach it with your response.

CONSTRUCTION PHASE ACTIVITIES

[Please feel free to call your Regional Sask Water Office for details on this Project.]

Background Information

A.7 What date did surveys and project design work begin? _____

A.8 What date were surveys and project design works completed? _____

A.9 What date did project construction begin? _____

A.10 What date was project construction completed? _____

A.11 What date did the project begin to operate and benefits begin to flow? _____

A.12 What is the projected life of the project (i.e., period of years over which benefits are expected to continue without additional major capital investments)? _____ years.

A.13 Was the project completed in a single phase of activities? If **NO**, please repeat answers to Questions A.9 to A.12 in the space below, for each phase.

Project Costs

A.14 What were the total costs of project planning, design and surveys, if known? $_____

(The total project planning costs would be largely government costs, unless the C & D Authority or Sask Water can verify other up front costs.)

A.15 How were project planning, design and survey costs shared?

C & D Area Authority	_____%
Sask Water or Sask Ag and Food	_____%
Other	_____%
Total	100 %

A.16 What was the total project construction (capital) cost? $ _____

(Please include in this total all direct and associated costs. For example, if a road or bridge needed upgrading because of the project, include it in the associated cost.)

A.17 How were the project capital costs shared

C & D Area Authority	_____%	
Sask Water or Sask Ag and Food	_____%	
Rural Municipalities	_____%	(Costs for bridges, culverts, roads, etc.)
Other	_____%	
Total	100 %	

A.18 How were the total capital costs of the project, noted above, spent over time?

Year	Total Invested ($)	Year	Total Invested ($)
19		19	

A.19 What proportion of total project construction costs were spent on each of the following items and approximately where were the funds spent?

Construction Item	Where Funds Were Spent (%)			
	Within 50 miles	Elsewhere in Province	Outside of Province	Total
Earthmoving				100%
Bridges/culverts				"
Control gates				"
Buildings & equipment				"
Right of way				"
Drop structures				"
Drop inlets				"
Other				"

A.20 Estimate how many persons worked on the project during construction for how many months. (This excludes Sask Water or government staff but may include CAA board members or board designates.)

_____ person-months (e.g., 6 persons worked 12 months = 72 person-months)

A.21 At the end of the project, what is your estimate of the value of the project (salvage values) – structures that could still be useful?

OPERATING AND MAINTENANCE COSTS

A.22 List total annual operating and maintenance costs to date since the project began operation.

Year	Total Expenditure ($)	Year	Total Expenditure ($)
19		19	

A.23 What is your best estimate for the annual maintenance cost for the project in the future years?

(One way to estimate this cost may be some average of the past few years, unless some new expenditures are anticipated. If the latter is the case, you may bring these additional expenses in your estimate given below

_____

_____

_____

A.24 How were the project operating and maintenance costs shared?

	Prior to 1992	1993 to Current Year
C & D Area Authority	_____ %	_____ %
Sask Water or Sask Ag and Food	_____ %	_____ %
Other	_____ %	_____ %
Total	100 %	100 %

A.25 What proportion of total project operating and maintenance costs were spent on each of the following items?

Labour	_____ %
Materials & supplies	_____ %
Other	_____ %
Total	100 %

A.26 Estimate how many persons typically work on the project performing operation and maintenance for how many months each year.

_____ person-months per year (e.g., 3 persons work 2 months per year = 6 person-months per year)

PART B
DRAINAGE AND FLOOD CONTROL PROJECT

B.1 What is the total land area included within the boundaries of the project? _____ acres

(Please indicate the area targeted for reduction in flooding. The boundaries of the project are the assessed boundaries, which should be equal to the effective drainage area of the project.

B.2 What was the frequency of flooding without the project? {Please provide details on the affected area associated with different types of floods (i.e., floods of different frequency – one in 10 years floods, 1 in 5 years floods, and so on}

B.3 How has the project changed the frequency and intensity of flooded area?

AGRICULTURAL IMPACTS OF THE PROJECT

B.4 Estimate land use in the project area before and after the project.

Land Use	If the Project were not in place (acres)	With the Project in place (acres)
Total crops		
Wheat		
Other cereals		
Canola		
Pulses		
Other crops		
Summerfallow		
Improved forage		
Unimproved pasture		
Woodland/other unimproved land		
Sloughs		
Area in project ditches, etc.		

B.5 Please indicate the area directly reclaimed by drainage as cultivated land as a result of the project _____ acres

B.6 Please indicate any other area that might have benefitted (or damaged) from the project (although not directly being flooded before)

_____

B.7. Describe the effects of the project on land use, agricultural practices, crop rotations and farming efficiency.

B.8 What effect did the project have on crop yields, if any? (i.e., types of crops and yield improvements associated with each type of crop.)

B.9 Please estimate the magnitude of improvements on the above (not directly flooded lands) resulting from the project.

B.10 Did the project create any land that could not be used for agriculture purposes? (e.g., land cut off by ditches, etc.) If so, how much area? _____ acres

B.11 Did the project result in any additional land clearing in the area? (i.e., this would include during and following construction of the project and any subsequent land clearing.)

B.12 Did the project contribute to livestock production or any increase in livestock production in the area? If so, describe the impact and quantify, if possible.

NON-AGRICULTURAL IMPACTS OF THE PROJECT

B.13 Did the project increase or decrease the amount of land available for use as wildlife or waterfowl habitat? If so, estimate direction and amount of change in the wildlife or waterfowl population.

B.14 Has the project contributed to increased or decreased beaver population in the project region or in the surrounding region?

B.15 If the beaver population has increased, please estimate the damage that is being caused by this change in the project and the surrounding region.

B.16 Has the project had any effects on recreation activities – hunting, nature walks, winter sports, etc? If so, describe the effect and quantity if possible.

B.17 Has the project had any effects on other water bodies in the region? (e.g., a flood control project may have positive or negative impacts on a downstream lake or on an upstream wetland.)

B.18 Has the project had any effects on surface or ground water quality, ground water levels, salinity, etc? If so, describe the effect and quantity if possible.

B.19 Did the project create any additional soil erosion in either the project region or in the surrounding region?

B.20 Describe any other effects the project has had on farmers, the local community, local government or any other agencies. These could include community economics, social impacts or impacts to agriculture not previously covered (e.g., a large flood control project could have had an impact on bringing an industry or large intensive livestock operation to a local community, because it improved feed production in the area.)

PART C
BACKFLOOD IRRIGATION PROJECT

C.1 What is the total land area included within the boundaries of the project? _____ acres

(Please indicate the area targeted for irrigation, over and above what was being irrigated before the project, if any.)

AGRICULTURAL IMPACTS OF THE PROJECT

C.2 Was there any irrigation associated with the area prior to the project? If so, indicate what type of irrigation and the area irrigated. _____ acres.

C.3 Please estimate the increase in area being irrigated as a result of the project. _____ acres

C.4 What is the distribution of irrigated area associated with the project by type of irrigation system?

Backflood _____ Springflood _____
Sprinklers _____ Others (Specify) _____

C.4 What crops are being grown under irrigation?

C.5 Please estimate the yield per acre for these crops under irrigation.

C.6 What crops would likely be grown on these lands without the project (i.e., under dryland conditions)?

C.7 Please estimate the yield per acre for these crops grown in the area under dryland conditions.

C.8 Describe the effects of the project on land use, agricultural practices, crop rotations and farming efficiency.

C.9 Did the project create any land that could not be used for agriculture purposes? (e.g., land cut off by ditches, etc.) If so, how much area? _____ acres

C.10 Did the project result in any additional land clearing in the area? (i.e., this would include during and following construction of the project and any subsequent land clearing.)

C.11 Did the project contribute to livestock production or any increase in livestock production in the area? If so, describe the impact and quantify, if possible.

NON-AGRICULTURAL IMPACTS OF THE PROJECT

C.12 Did the project increase or decrease the amount of land available for use as wildlife or waterfowl habitat? If so, estimate direction and amount of change and if hunting has been affected.

C.13 Has the project had any effects on surface or ground water quality, ground water levels, salinity, recreation, etc? If so, describe the effect and quantity if possible.

C.14 Did the project affect (increase or reduce) flooding of agricultural lands in the surrounding region?

C.15 Describe any other effects the project has had on farmers, the local community, local government or any other agencies. These could include community economics, social impacts or impacts to agriculture not previously covered (e.g., a large flood control project could have had an impact on bringing an industry or large intensive livestock operation to a local community, because it improved feed production in the area.)

PART D

LAKE LEVEL STABILIZATION PROJECT

D.1 What is the total land area included within the boundaries of the project? _____ acres

(Please include the area that now can be used for various purposes (e.g., agriculture, recreation, cottage development) that was unavailable before the project.)

AGRICULTURAL IMPACTS OF THE PROJECT

D.2 What area is now protected or subject to lesser flooding as a result of the project? _____acres

D.3 What additional area can now be cultivated because of the project? _____ acres

D.4 Describe the effects of the project on land use, agricultural practices, crop rotations and farming efficiency.

D.5 What effect did the project have on crop yields, if any? Please indicate average crop yields before and after the project for typical crops grown in the area.

D.6 Did the project create any land that could not be used for agriculture purposes? (e.g., land cut off by ditches, etc.) If so, how much area? _____ acres

D.7 Did the project result in any additional land clearing in the area? (i.e., this would include during and following construction of the project and any subsequent land clearing.)

D.8 Did the project contribute to livestock production or any increase in livestock production in the area? If so, describe the impact and quantify, if possible.

NON-AGRICULTURAL IMPACTS OF THE PROJECT

D.9 Did the project increase or decrease the amount of land available for use as wildlife or waterfowl habitat? If so, estimate direction and amount of change and if hunting has been affected.

D.10 Has the project had any effects on surface or ground water quality, ground water levels, salinity, etc? If so, describe the effect and quantity if possible.

D.11 Did the project lead to any increased or decreased recreational use of the area surrounding the Lake?

_____ No ____ Yes If yes, please answer the following question:

D.12 Did the project result in people visiting the area for activities such as:

Activities	Change in the No. of Visitors	Change in the No. of Days
Day visitors during summer	_____	_____
Campers	_____	_____
Winter recreationists	_____	_____
Fishing	_____	_____
Ice Fishing	_____	_____
Others (Please describe)	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

D.13 Did the project result in additional cottage development around the Lake? If yes, please describe the magnitude of this change.

D.14 Has the project contributed to increased or decreased beaver population in the project region or in the surrounding region?

D.15 If the beaver population has increased, please estimate the damage that is being caused by this change in the project and the surrounding region.

D.16 Did the project result in any increased (or reduced) flooding of the project region areas? If yes, provide details.

D.17 Did the project result in any increased (or reduced) flooding of the surrounding areas? If yes, provide details.

D.18 Describe any other effects the project has had on farmers, the local community, local government or any other agencies. These could include community economics, social impacts or impacts to agriculture not previously covered (e.g., a large flood control project could have had an impact on bringing an industry or large intensive livestock operation to a local community, because it improved feed production in the area.)

PART E
MULTI-PURPOSE PROJECTS

For a multi-purpose project, please identify two or more impacts similar to the above impacts. Complete two or more of Parts B, C or D of the survey form that are applicable to the impacts from the project.

OTHER COMMENTS

Please record any other benefits or impacts of the project not listed above.

Please record any other aspects or impacts of the project not mentioned in any of the previous sections.